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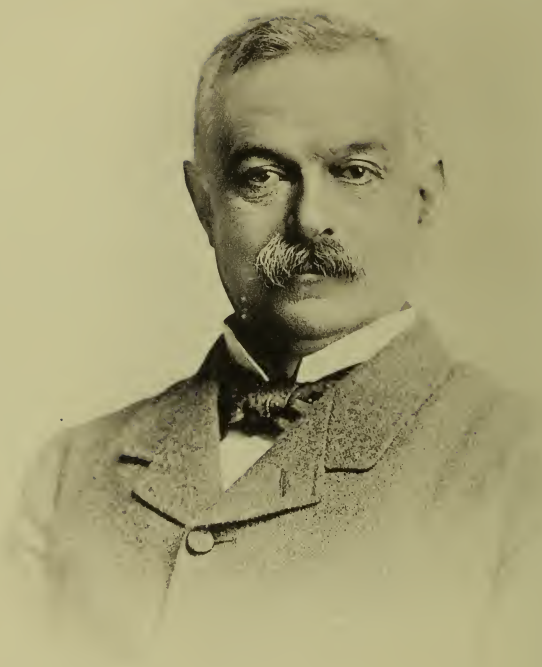

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PROCEEDINGS

OF THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS

VOLUME XXII. 1895-96

EDITED BY

THOMAS COLE

ASSOC. M. INST. C.E.

(*Secretary of the Association*)

The Association is not as a body responsible for the facts and opinions advanced herein.

London:

E. & F. N. SPON, 125 STRAND

New York:

SPON & CHAMBERLAIN, 12 CORTLANDT STREET

1896

LONDON:

PRINTED BY WILLIAM CLOWES AND SONS, LIMITED, STAMFORD STREET
AND CHARING CROSS.

CONTENTS.

Frontispiece Portraits—

1. H. Percy Boulnois, M. Inst. C.E., *Past President.*
2. Edward R. S. Escott, M. Inst. C.E., *Past President.*

	PAGE
List of Officers	v
List of Members	vii
List of Towns and Districts Represented	xxiii
Districts	xxxiii
List of Graduates	lxiii
Parliamentary Committee	lxiv
Bye-Laws	lxv
Annual Report and Financial Statement for Year ending April 30th, 1896	1
Appointment of Scrutineers	6
„ „ Auditors	6

District Meetings—

Meeting at Londonderry and Portrush:

The Electric Lighting of the City of Londonderry. J. Christie	9
Municipal Electricity. J. Perry	17
Discussion	27
Visit to Works	33
Light Railways and Tramways. R. H. Dorman	34
Discussion	44
The Headquarters of the Belfast Fire Brigade. J. Munce	53
Discussion	61
Visit to Works	63

Meeting at Westminster:

Some Suggested Amendments of the Metropolis Local Management Acts. J. P. Barber	64
Discussion	73
Notes on the Wear of Hard Wood Paving and the Weight of Traffic thereon. W. N. Blair	85
Hard Wood Paving. J. P. Norrington	91
Discussion	94

Adjourned Meeting at Westminster:

Further Discussion on Mr. Barber's Paper	102

Meeting at King's Heath:

Fourteen Years' Work in a Midland Suburb. R. Godfrey	121
Discussion	136
Visits to Works	144

41081

District Meetings (*continued*)—

Meeting at Kew, Twickenham and Hampton:

PAGE

Richmond Main Sewerage Board Works, Mortlake. W. Fairley .. 145
Discussion .. 153
Visits to Works .. 155

Meeting at Hanley:

Some of the Public Works carried out in Hanley during the past Ten Years. J. Lobley .. 162
Discussion .. 173
Visits to Works .. 179

Annual Meeting at Brighton:

The President's Address .. 181
River Pollution. Professor H. Robinson .. 196
Discussion .. 199
Disposal or Utilisation of the Residue from Towns Refuse Destructors. H. P. Boulnois .. 211
Discussion .. 217
Housing of the Working Classes—Model Cottages—Tenement Buildings and Municipal Lodging Houses. J. H. Brierley .. 228
Discussion .. 238
Electric Traction: a review of its application, and a comparison with other methods. R. St. George Moore .. 252
Discussion .. 260
Street Construction for Medium Traffic. A. E. Collins .. 268
Discussion .. 274
Steam Rolling. E. P. Hooley (Plates) .. 284
Discussion .. 299
Footways. C. H. Cooper (Plate) .. 309
Discussion .. 321
Visits to Works .. 329

Appendix:

Description of Public Works Visited at Brighton .. 332
List of Books of Statistics at Offices of the Association .. 342
Examinations .. 347
Board of Examiners .. 357
Certificated Candidates .. 358

Memoirs of Deceased Members .. 363

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SAVAGE, W. H. .. .. .. Surveyor to Urban District Council, East Ham.
SAVILLE, J. .. .. Town Surveyor, Heckmondwike.
SCORGIE, N., A.M. Inst. C.E. Vestry Surveyor, Rotherhithe, S.E.
SCOTT, A. F. .. .. Surveyor to the Urban District Council, Cromer.
SCOTT, E. M. .. .. Borough Surveyor, Wednesbury.
SCOTT, H. H., A.M.Inst.C.E. Engineer to the Commissioners, Hove.
SCOTT, R. S., Assoc. M. Inst. C.E. Surveyor to the Urban District Council, Bishop's Stortford.
SENIOR, J. S. .. .. Surveyor to the Urban District Council, Swanage.
SHACKLETON, C. W. .. .. Surveyor to Urban District Council, Coseley.
SHARMAN, E. .. .. Surveyor to Urban District Council, Wellingborough, Northamptonshire.
SHAW, H., Assoc.M.Inst.C.E. Surveyor to Urban District Council, Todmorden.
SHAW, J. H. .. .. Surveyor to the Urban District Council, Borwnhills, Staffs.
SHEARD, W. C. .. .. .. Surveyor to the Urban District Council, Heaton Norris, Stockport.
SHEPHERD, G. J. .. .. .. Highway Surveyor, Kidderminster.
SHEPPARD, G. .. .. .. Borough Surveyor, Newark.
SHILLINGTON, H. .. .. .. Town Surveyor, Lurgan, Ireland.
SHIPTON, G. H. .. .. .. Surveyor to the Urban District Council, Oldbury.
SIDDONS, J. M. .. .. .. Surveyor, Oundle.
SIDWELL, H. T. .. .. .. Surveyor to the Blean Rural District Council, Herne, Canterbury.
SILCOCK, E. J., A.M.Inst.C.E. Borough Surveyor, King's Lynn.
SIMPSON, J. .. .. Surveyor, Wirksworth, Derbyshire.
SIMPSON, W. H., A.M.Inst.C.E. Horsefair Street, Leicester.
SINCLAIR, J. S., A.M.Inst.C.E. Borough Surveyor, Widnes.

Skelton, R., A.M. Inst. C.E.	Municipal Engineer, Colombo, Ceylon.
Smillie, J. F.	Borough Surveyor, Tynemouth.
Smith, C. C.	Surveyor to the Urban District Council, Dalton-in-Furness.
Smith, I. C.	Surveyor to Rural District Council, Chelmsford.
Smith, J., Assoc. M. Inst. C.E.	County Surveyor, Co. Galway (E. Riding), Ballinasloe.
Smith, J. B.	Surveyor to Urban District Council, Tyldesley.
Smith, J. C., A.M. Inst. C.E.	Borough Surveyor, Bury St. Edmunds.
Smith, J. W. M. (*Member of Council*)	Borough Surveyor, Wrexham, Denbighshire; *Hon. Secretary*, Wales District.
Smith, T. R., A.M. Inst. C.E.	Surveyor to the Urban District Council, Kettering.
Smith, W. H., Assoc. M. Inst. C.E.	City Engineer, Carlisle.
Smithies, A.	Surveyor to the Urban District Council, Trent Boulevard, West Bridgford.
Smythe, F.	Surveyor to Urban District Council, Finchley, N.
Somerville, R. N., B.E. ..	County Surveyor, Cavan, Ireland.
Southam, A., A.M. Inst. C.E.	Surveyor, Clapham, London, S.W.
Spencer, J. P., A.M.Inst.C.E.	32 Moseley Street, Newcastle-on-Tyne.
Spinks, W., Assoc. M. Inst. C.E.	52 Prudential Assurance Buildings, Park Row, Leeds.
Stainthorpe, T.W., A.M.Inst. C.E. (*Member of Council*)	Surveyor to Eston District Urban District Council, Yorkshire; *Hon. Sec.*, Yorkshire District.
Stallard, S.	Surveyor to Rural District Council, Maidstone.
Stead, S.	Borough Surveyor, Harrogate.
Stephenson, E. P., Assoc. M. Inst. C.E.	Town Surveyor, Llandudno.
Stevens, G.	Surveyor to the Urban District Council, Abercarn, Mon.
Stevens, L.	Surveyor to the Urban District Council, Newton Abbott, Devon.
Stevenson, A.	District Surveyor, Ayrshire County Council.
Stevenson, J.	Surveyor to Urban District Council, East Molesey.
Stickland, E. A., Assoc. M. Inst. C.E.	Borough Surveyor, Newbury.
Stirrat, J.	Municipal Engineer, Rangoon.
Stokoe, J.	Surveyor to Urban District Council, Altrincham.
Story, J. S., M. Inst. C.E. ..	County Surveyor, Derby.
Strachan, J...	Municipal Engineer, Kurachi.
Stringfellow, H. W.	City Surveyor, Chichester.
Stringfellow, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, East Cowes, Isle of Wight.
Stuart, J. C.	Surveyor to Urban District Council, Smethwick
Stubbs, W., A.M. Inst. C.E.	Borough Engineer, Blackburn.
Sumner, F., A.M. Inst. C.E.	Vestry Surveyor, Bermondsey.
Surtees, R. T.	Wentworth Place, Hexham-on-Tyne.
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Tanner, W.	County Surveyor, Monmouthshire. Newport.
Tarbit, T. H.	Surveyor to the Urban District Council, Loftus, Yorkshire.
Taylor, H. W.	Surveyor to the Urban District Council, Newburn-on-Tyne.
Taylor, R.	Borough Surveyor, Haslingden.
Terrill, W.	Surveyor to Urban District Council, Ashford, Kent.

THOMAS, J., A.M. Inst. C.E.	Surveyor to the Rural District Council, Swansea.
THOMAS, R. J., A.M.Inst.C.E.	County Surveyor, Bucks. Aylesbury.
THOMAS, T. J., A.M.Inst.C.E.	Surveyor to Urban District Council, Ebbw Vale.
THOMAS, W., A.M. Inst. C.E.	1 Above Bar Street, Southampton.
THOMAS, W. E. C., A.M. Inst. C.E. (*Member of Council.*)	Surveyor to the Rural District Council, Neath; *Hon. Secretary*, South Wales District.
THOMPSON, G. W., Assoc. M. Inst. C.E.	Vestry Surveyor, St. Olave, Southwark.
THORBURN, T. C.	17 Devonshire Road, Birkenhead.
THORPE, J.	Surveyor to Rural District Council, Macclesfield.
TILL, W. S., M. Inst. C.E. (*Past President.*)	Borough Engineer, Birmingham.
TOMES, G. B...	Surveyor to the Barnes District Urban District Council, Mortlake.
TOMKINS, H., A. M. Inst. C.E.	Vestry Surveyor, St. Marylebone.
TOOLEY, H.	Surveyor to the Urban District Council, Buckhurst Hill, Essex.
TOWLSON, S.	Surveyor to the Urban District Council, Cheshunt.
TRAVERS, W. H.	Surveyor to Urban District Council, Wavertree.
TROW, S...	Surveyor to the Urban District Council, Otley, Yorkshire.
TULEY, W.	Surveyor to the Urban District Council, Rothwell, near Leeds.
TURLEY, A. C., A.M.Inst.C.E.	Borough Engineer, Eccles.
TURNBULL, A. J.	Borough Engineer, Greenock.
VALLANCE, R. F.	Borough Surveyor, Mansfield.
VALON, W. A. MCINTOSH, Assoc. M. Inst. C.E.	Ramsgate Corporation Gasworks Engineer; and 140 and 141 Temple Chambers, Temple Avenue, E.C.
VEEVERS, H., A. M. Inst. C.E.	Surveyor to Urban District Council, Dukinfield.
VENTRIS, A., Assoc. M. Inst. C.E.	Surveyor to the Strand District Board of Works. 49 Seymour Street, Portman Square.
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WAKELAM, H. T., Assoc. M. Inst. C.E.	County Surveyor, Hereford.
WALKER, T., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Croydon, Surrey.
WALLACE, G.	Surveyor to St. Giles' District Board of Works.
WALSHAW, J. W.	Borough Surveyor, Peterborough.
WARDLE, J. W., A.M.Inst.C.E.	Borough Surveyor, Longton.
WATERHOUSE, D.	Surveyor to the Urban District Council, Watford.
WATKEYS, G., A.M.Inst.C.E.	Surveyor to the Urban District Council, Llanelly.
WATSON, J. D., A.M.Inst.C.E.	County Engineer, Aberdeenshire.
WATTS, E. T.	Surveyor to the Rural District Council, Bishop's Stortford.
WATTS, W.	Water Engineer, Oldham.
WAYE, H.	Surveyor to the Urban District Council, Millom, Cumberland.
WEAVER, W., M. Inst. C.E. (*Member of Council.*)	Vestry Surveyor, Kensington.
WEBSTER, J. L.	Surveyor to the Urban District Council, Portland.
WEBSTER, R. J.	Surveyor to the Urban District Council, Castleton, Manchester.
WELBURN, W.	Borough Surveyor, Middleton, near Manchester.
WESTON, G.	Vestry Surveyor, Paddington.
WESTON, H. J., Assoc. M. Inst. C.E.	Late Surveyor to the Urban District Council, Shirley and Freemantle, Southampton.

WETHERILL, J. W.	Surveyor to Urban District Council, Rawmarsh.
WHEELER, G. R. W., Assoc. M. Inst. C.E. (*Member of Council.*)	Vestry Surveyor, Westminster; *Hon. Secretary*, Metropolitan District.
WHITBREAD, R.	Surveyor to the Urban District Council, Carlton, Notts.
WHITE, A. E., M. Inst. C.E. ..	Borough Engineer, Hull.
WHITE, H. V., M. Inst. C.E. I.	County Surveyor, Queen's County. Portarlington.
WHITE, J., Assoc.M.Inst.C.E.	Borough Surveyor, Folkestone.
WHITE, W. H., M. Inst. C.E. (*Past President.*)	City Engineer, Oxford.
WHITEHEAD, C. L., jun. ..	Surveyor to the Urban District Council, Wembley.
WIDDOWSON, W. C.	Surveyor to the Urban District Council, Tredegar, Mon.
WIKE, C. F., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Sheffield.
WILD, G. H.	Surveyor to Urban District Council, Littleborough, near Manchester.
WILDING, J.	Surveyor to the Urban District Council, Runcorn.
WILLIAMS, H. D.	Surveyor to the Urban District Council, Ogmore and Garrw, Bridgend.
WILLIAMS, J. B.	Borough Surveyor, Daventry.
WILLIAMS, J.	Surveyor to Urban District Council, Mountain Ash.
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WILLMOT, J.	County Surveyor, Warwickshire. 6 Waterloo St., Birmingham.
WILLSON, F. R. T.	County Surveyor, Co. Fermanagh, Enniskillen.
WILSON, C. L. N., Assoc. M. Inst. C.E.	Town Surveyor, Bilston.
WILSON, G.	Surveyor to the Urban District Council, Alnwick.
WILSON, J.	Borough Surveyor, Bacup, Lancashire.
WILSON, J. B.	Surveyor to the Rural District Council, Cockermouth.
WILSON, R. A.	Surveyor to the Urban District Council, Carshalton.
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WINTER, O. E., Assoc. M. Inst. C.E.	Vestry Surveyor, St. George the Martyr, Southwark.
WOOD, A. R.	Surveyor to the Urban District Council, Tunstall.
WOOD, F. J.	County Surveyor, Hubert Place, Lancaster.
WOODBRIDGE, C. A.	Surveyor to the Hendon Union Rural District Council. Pinner, Middlesex.
WOODS, H.	District Surveyor, Plumstead (Parishes of Lee and Kidbrook). Dryden Terrace, Turner Road, Lee, Kent.
WORTH, J. E., M. Inst. C.E.	District Engineer, London County Council, Spring Gardens, S.W.
WRIGHT, A., A.M. Inst. C.E.	Electrical Engineer, Brighton.
WYATT, W. J.	Surveyor to the Urban District Council, Paignton, Devon.
WYNNE-ROBERTS, R. O., Assoc. M. Inst. C.E.	Borough Surveyor, Oswestry.
YABBICOM, T. H., Assoc. M. Inst. C.E.	City Engineer, Bristol.
YATES, F. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Waterloo, near Liverpool.
YORK, H.	Surveyor to the Urban District Council, East Barnet Valley. Station Road, New Barnet.

TOWNS AND DISTRICTS

REPRESENTED BY MEMBERS OF THE ASSOCIATION.

Abercarne	G. Stevens.
Aberdeen	W. Dyack.
Aberdeenshire	J. D. Watson.
Abergavenny	J. Haigh.
Abersychan	E. Cooke.
Aberystwyth	R. Jones.
Abingdon	G. Winship.
Abram	G. Heaton.
Accrington	W. J. Newton.
Acton	D. J. Ebbetts.
Allerton	A. O. Fraser.
Alnwick	G. Wilson.
Altrincham	J. Stokoe.
Alverstoke	W. H. Fry.
Antrim (County).	J. H. Brett.
Armagh (County)	R. H. Dorman.
Ashby-de-la-Zouch	G. H. Lilley.
Ashby Woulds	C. T. Garratt.
Ashford	W. Terrill.
Ashton-under-Lyne	J. T. Earnshaw.
Aspull	G. Heaton.
Aston	H. Richardson.
„ (Rural)	R. H. Hawgood.
Atherton	W. Clough.
Audenshaw	J. H. Burton.
Aylesbury	J. H. Bradford.
Ayrshire (County)	A. Stevenson.
Bacup	J. Wilson.
Banbury	N. H. Dawson.
Barking	C. J. Dawson.
Barmouth	T. Blackburn.
Barnes	G. B. Tomes.
Barrow-on-Soar (Rural)	H. Herrod.
Barry	J. C. Pardoe.
Barton-upon-Irwell	C. C. Hooley.
Batley	H. Dearden.
Battersea	J. T. Pilditch.
Beckenham	J. A. Angell.
Bedford	J. Lund.
„ (County)	W. H. Leete.
Bedlington	W. W. Cooper.
Belfast	J. C. Bretland.
Belper	R. C. Cordon.
Benwell	W. P. Pattison.
Bermondsey	F. Sumner.
Berwick-on-Tweed	R. Dickinson.
Bethnal Green	F. W. Barratt.
Bexhill	M. D. Graves.

Biggleswade	J. W. B. Rooke.
Biggleswade (County)	G. W. Manning.
Billesden (Rural)	W. F. Ault.
Bilston	C. L. N. Wilson.
Bingley	R. Armistead.
Birkenhead	C. Brownridge.
Birmingham	J. Price.
Bishop's Castle	A. Hamar.
Bishop's Stortford	R. S. Scott.
„ „ (Rural)	E. T. Watts.
Blaby (Rural)	W. King.
Blackburn	W. Stubbs.
Blean	H. T. Sidwell.
Bolton	W. H. Brockbank.
Bombay	M. C. Murzban.
Bootle	J. A. Crowther.
Bournemouth	F. W. Lacey.
Bowdon	J. Newton.
Brackley	A. A. Green.
Bradford	J. H. Cox.
Braintree	H. H. Nankivell.
Bray	P. F. Comber.
Brecknock	R. Davies.
Brentford	N. Parr.
Bridgwater	F. Parr.
Bridlington	R. R. Brown.
Brierfield	J. T. Landless.
Brierley Hill	J. W. Beckley.
Brighton	F. J. C. May.
Brisbane, Queensland	T. Kirk.
Bristol	T. H. Yabbicom.
„ (St. George)	T. L. Lewis.
Broadstairs	H. Hurd.
Bromley	S. T. Hawkings.
Brownhills	J. H. Shaw.
Buckhurst Hill	H. Tooley.
Buckingham (County)	R. J. Thomas
Bucklow	J. McD. McKenzie.
Burnham	W. J. Press.
Burnley	G. H. Pickles.
„ (Rural)	S. Edmondson.
Burslem	F. Bettany.
Bury	J. Cartwright.
Bury St. Edmunds	J. C. Smith.

Canterbury	A. H. Campbell.
Cape Town, S.A.	T. W. Cairncross.
Cardiff	W. Harpur.
„ (Rural)	W. Fraser.
Carlisle	W. H. Smith.
Carlton	R. Whitbread
Carshalton	R. A. Wilson.
Castleton	R. J. Webster.
Cavan (County)	R. N. Somerville.
Caversham	W. R. Locke.
Chadderton	W. Eckersley.
Charlton	J. Rowland.
Cheadle	E. Sykes.
Chelmsford	G. H. Sasse.
„ (Rural)	I. C. Smith.
Chelsea	T. W. E. Higgens.

Cheltenham	J. Hall.
Cheshunt	S. Towlson.
Chester	I. M. Jones.
Chesterfield	N. Dunscombe.
Chesterton	D. Bland.
Chichester	H. W. Stringfellow.
Chorley	W. Leigh.
Christchurch	R. W. Knapp.
Clacton-on-Sea	A. R. Robinson.
Clapham, S.W.	A. Southam.
Cleator Moor	F. J. Edge.
Cleethorpes	E. Rushton.
Clerkenwell	W. Iron.
Clevedon	G. W. Knowles.
Coalville	L. L. Baldwin.
Cockermouth (Rural)	J. B. Wilson.
Colchester	H. Goodyear.
Colne	T. H. Hartley.
Colombo	R. Skelton.
Colwyn Bay	W. Jones.
Congleton	R. Burslam.
Conway	T. B. Farrington.
Cookham	F. Laurens.
Cork (County), West	N. Jackson.
„ „ South	S. A. Kirkby.
„ „ East	A. O. Lyons.
Cornwall (County), West	T. J. Hickes.
Coseley	C. W. Shackleton.
Coventry	E. J. Purnell.
Cowpen	R. Grieves.
Crewe	G. Eaton-Shore.
Cromer	A. F. Scott.
Crompton	J. H. Mills.
Croydon	T. Walker.
Cupar (Fife)	T. Aitken.
Dalton-in-Furness	C. C. Smith.
Daventry	J. B. Williams.
Deal	T. C. Golder.
Denton	G. H. Newton.
Derby	R. J. Harrison.
„ (County)	J. S. Story.
Desborough	O. Pemberton.
Dewsbury	H. C. Marks.
Doncaster	W. H. R. Crabtree.
„ (Rural)	C. C. Barras.
Donegal (County) South	R. W. F. Longfield.
Dorchester	G. J. Hunt.
Dorking	G. S. Mathews.
„ (Rural)	W. Rapley, jun.
Down (County)	P. C. Cowan.
Droitwich	T. P. Baylis.
Dublin	C. Harty.
„ (County)	R. A. Gray.
„ „ South Division	W. Collen.
Dudley	J. Gammage.
Dukinfield	H. Veevers.
Durham (Rural)	G. Gregson.
Ealing	C. Jones.
East Barnet Valley	H. York.

East Cowes	W. Stringfellow.
East Dereham	H. G. Himson.
East Ham	W. H. Savage.
East Molesey	J. Stevenson.
East Stonehouse	A. Debnam.
Eastbourne	R. M. Gloyne.
Ebbw Vale	T. J. Thomas.
Eccles	A. C. Turley.
Edinburgh	J. Cooper.
Eltham	R. Findlay.
Enfield	R. Collins.
Epsom	E. R. Capon.
Erith	H. Hind.
Eston District	T. W. Stainthorpe.
Evesham	R. C. Mawson.
Exeter	D. Cameron.
Exmouth	W. H. Beswick.
Eye	J. Rush.
Fareham	W. Butler.
Farnham	H. Frost.
Featherstone	A. Sutcliffe.
Felixstowe	G. S. Horton.
Fenny Stratford	J. Chadwick.
Fermanagh (County)	F. R. T. Willson.
Finchley	F. Smythe.
Fleetwood	M. S. Gaulter.
Folkestone	J. White.
Friern Barnet	E. J. Reynolds.
Frodsham	W. Diggle.
Frome	P. Edinger.
„ (Rural)	A. Greenwell.
Gainsborough	H. Riley.
Galway (County), West	J. Perry.
„ „ East	J. Smith.
Garston	H. T. Wakelam.
Gateshead-on-Tyne	J. Bower.
Gloucester	R. Read.
„ (County)	R. Phillips.
Glyncorrwg	J. Howell.
Godaveri, Madras	P. H. Brown.
Grantham	J. Evans.
Grays Thurrock	A. C. James.
Great Crosby	W. Hall.
Great Grimsby	M. Petree.
Great Yarmouth	J. W. Cockrill.
Greenock	A. J. Turnbull.
Guildford	J. Dewhirst.
„	F. T. Maltby.
Halifax	E. R. S. Escott.
„ (Rural)	J. W. Dyson.
Hammersmith	H. Mair.
Hampstead	C. H. Lowe.
Hampton	J. Kemp.
Hanley	J. Lobley.
Hants (County)	J. Robinson.
Hanwell	S. W. J. Barnes.
Harrogate	S. Stead.
Harrow	T. Charles.
Hartlepool	H. C. Crummack.

Harwich	H. Ditcham.
Haslingden	R. Taylor.
Haverhill	T. Cockrill.
Heaton Norris	W. C. Sheard.
Hebden Bridge	W. Calvert.
Hendon	S. S. Grimley.
„ (Rural)	C. A. Woodbridge.
Henley-on-Thames	R. Pratt.
Hereford	J. Parker.
„ (County)	H. T. Wakelam.
Herne Bay	F. W. J. Palmer.
Hertford	J. H. Jevons.
Heywood	J. Diggle.
Heckmondwike	J. Saville.
High Wycombe	T. J. Rushbrooke.
Hinckley	W. T. Howse.
Holborn	L. H. Isaacs.
Hong Kong	F. A. Cooper.
Horfield	A. P. J. Cotterell.
Hornsea	P. Gaskell.
Hornsey	E. J. Lovegrove.
Hounslow	W. A. Davies.
Hove	H. H. Scott.
Hoylake and West Kirby	T. Foster.
Hoyland Nether	W. Farrington.
Hull	A. E. White.
Hyde	J. Mitchell.
Ilfracombe	O. M. Prouse.
Ilkeston	H. J. Kilford.
Ilkley	W. A. Palliser.
Ipswich	E. Buckham.
Irlam	W. R. Kay.
Isle of Ely (County)	G. J. Moore.
Isle of Thanet	L. W. Hogbin.
Jarrow	J. Petree.
Johannesberg, S.A.	C. Aburrow.
„ „	G. R. Andrews.
Kearsley	T. Nuttall.
Keighley	W. H. Hopkinson.
Kendal	D. C. Goddard.
Kennington Green	J. P. Norrington.
Kensington	W. Weaver.
Kent (County)	F. W. Ruck.
Keswick	W. Hodgson.
Kettering	T. R. Smith.
Keynsham (R.D.C.)	H. M. Bennett.
Kidderminster	A. Comber.
„ (Highways)	G. J. Shepherd.
Kildare (County)	E. Glover.
Kilkenny	A. M. Burden.
King's County	R. B. Sanders.
King's Lynn	E. J. Silcock.
King's Norton (Rural)	R. Godfrey.
Kingston (Highway Board)	A. J. Henderson.
„ (Rural)	W. H. Hope.
„ Jamaica	C. V. Abrahams.
Kingswood	D. H. W. Powell.
Kirkleatham	J. Howcroft.

Kiveton Park	W. Atkinson.
Kurachi	J. Strachan.
Lancaster	J. Cook.
Lee	H. Woods.
Leeds	T. Hewson.
Leek	J. Myatt.
Leicester	E. G. Mawbey.
„	F. Griffiths.
Leith	W. Beatson.
Leitrim (County)	D. G. Ottley.
Leominster	E. Bailey.
Levenshulme	J. Jephson.
Lewes	T. W. Franks.
Lewisham	J. Carline.
Leyton, E.	W. Dawson.
Limerick (County)	J. Horan.
Lincoln	R. A. MacBrair.
Littleborough	G. H. Wild.
Littlehampton	H. Howard.
Liverpool	H. P. Boulnois.
Llandaff	J. Holden.
Llandudno	E. P. Stephenson.
„	T. T. Marks.
Llanelly	G. Watkeys.
Llantrissant	G. S. Morgan.
Loftus	T. H. Tarbit.
London (County)	A. R. Binnie.
„ „	J. E. Worth.
Londonderry	W. J. Robinson.
„	J. Christie.
Longford (County)	J. W. Gunnis.
Longton	J. W. Wardle.
Loughborough	G. Hodson.
Louth (County)	P. J. Lynam.
Lowestoft	G. H. Hamby.
Lurgan	H. Shillington.
Luton	A. J. L. Evans.
Lymington	O. A. Bridges.
Macclesfield	E. E. Adshead.
„ (Rural)	J. Thorpe.
Madras	R. E. Ellis.
Maidstone	T. F. Bunting.
„ (Rural)	S. Stallard.
Maldon	H. G. Keywood.
Malton	R. Richardson.
Malvern	H. P. Maybury.
Manchester	T. De C. Meade.
Mansfield	R. F. Vallance.
Mansfield Woodhouse	F. P. Cook.
Margate	A. Latham.
Market Harboro'	H. G. Coales.
Matlock Bath	W. Jaffrey.
Meath (County)	J. H. Moore.
Melton Mowbray	E. Jeeves.
Merthyr Tydvil	T. F. Harvey.
„ „ (Rural)	J. Jones.
Middlesbrough	F. Baker.
Middleton, Lancashire	W. Welburn.
Mile End	J. M. Knight.
Millom	H. Waye.

Milton-next-Sittingbourne	A. B. Acworth.
Mirfield	F. H. Hare.
Monaghan (County)	J. Heron.
Monmouthshire (County)	W. Tanner.
Morpeth	W. F. Curry.
Mountain Ash	J. Williams.
Neath (Rural)	E. W. C. Thomas.
Nelson	B. Ball.
Nelson-in-Marsden	W. Dent.
New Malden	T. L. Heward.
Newark	G. Sheppard.
Newburn-on-Tyne	H. W. Taylor.
Newbury	E. A. Stickland.
Newcastle-on-Tyne	W. G. Laws.
Newmarket	J. W. Metcalf.
Newport, Mon.	R. H. Haynes.
Newton Abbott	L. Stevens.
Newton-in-Makerfield	R. Brierley.
Newtown	R. W. Davies.
North Bierley	P. Ross.
North Mayo (County)	W. P. Orchard.
North Ormesby	H. T. Hopper.
Northampton	W. I. Brown.
,, (County)	E. Law.
Norwich	A. E. Collins.
Nottingham	A. Brown.
,, (County)	E. P. Hooley.
Nuneaton	J. S. Pickering.
Ogmore and Garrw	H. D. Williams.
Okehampton	H. Geen.
Oldbury	T. H. Shipton.
Oldham	S. A. Pickering.
,,	W. Watts.
Orrell	G. Heaton.
Oswestry	R. O. Wynne-Roberts.
Otley	S. Trow.
Oundle	J. M. Siddons.
Oxford	W. H. White.
Oystermouth	C. G. Bennett.
Paddington	G. Weston.
Padiham	J. Gregson.
Paignton	W. J. Wyatt.
Peebles (County)	R. S. Anderson.
Pemberton	G. Heaton.
Penang, Straits Settlements	R. Peirce.
Penarth	E. J. Evans.
Penmaenmawr	J. S. Coverley.
Perry Barr	H. H. Gammell.
Peterborough	J. W. Walshaw.
Plumstead	W. C. Gow.
Plymouth	J. Paton.
Pontardawe (Rural)	J. Morgan.
Poole	J. Elford.
Poplar	W. Oxtoby.
Portishead	J. Moss Flower.
Portland	J. L. Webster.
Portsmouth	P. Murch.
Prescot	W. Goldsworth.
Pudsey	R. W. Cass.

Putney	J. C. Radford.
Pwllheli	J. O. Jones.
Queen's County	H. V. White.
Rangoon	J. Stirrat.
Ramsbottom	T. Nuttall.
Ramsgate	M. Aspinall.
„	W. A. M. Valon.
Rawmarsh	J. W. Wetherill.
Reigate	F. D. Clark.
Retford	J. D. Kennedy.
Richmond	J. H. Brierley.
Ripon	W. Edson.
Rochdale	S. S. Platt.
Rochester	W. Banks.
Romford	G. Boden.
Rotherham	G. Jennings.
„ (Rural)	B. Godfrey.
Rotherhithe	N. Scorgie.
Rothwell	W. T. Pearson.
„	W. Tuley.
Rowley Regis	W. H. Brettell.
Rugby	D. G. MacDonald.
Rugeley	W. E. Rogers.
Runcorn	J. Wilding.
Ryde	F. Newman.
Ryton-on-Tyne	J. P. Dalton.
Saffron Walden	G. W. Lacey.
St. George, Bristol	T. L. Lewis.
St. George, Southwark	O. E. Winter.
St. George's, Hanover Square	G. Livingstone.
St. Giles	G. Wallace.
St. Helen's	G. J. C. Broom.
St. Luke, Middlesex	M. C. Meaby.
St. Martin-in-the-Fields	C. Mason.
St. Mary, Islington	J. P. Barber.
St. Mary, Newington	J. A. P. Waddington.
St. Marylebone	H. Tomkins.
St. Olave, Southwark	G. W. Thompson.
St. Pancras	W. N. Blair.
St. Saviour, Southwark	G. R. Norrish.
Sale	A. G. McBeath.
Sandwich	A. J. Catt.
Sevenoaks	J. Mann.
Shanghai, China	C. Mayne.
Sheerness	C. A. Copland.
Sheffield	C. F. Wike.
Sherborne	T. Farrall.
Shifnal, Salop	W. F. Y. Molineux.
Shildon	W. A. Mason.
Shoreditch	J. R. Dixon.
Shrewsbury	W. C. Eddowes.
Shropshire (County)	A. T. Davis.
Skelton-in-Cleveland	W. P. Robinson.
Skipton	T. Mallinson.
„	A. Rodwell.
Sleaford	J. Clare.
Slough	J. Baker.
Smethwick	J. C. Stuart.
Solihull (Rural)	A. E. Currall.
Somerton	I. T. Hawkins.
South Brisbane	T. C. Deverell.
South Hornsey	M. W. Jameson.

South Mayo	E. K. Dixon.
South Shields	M. Hall.
Southall—Norwood	H. R. Felkin.
Southampton	W. B. G. Bennett.
Southend-on-Sea	H. Harlock.
Southgate	C. G. Lawson.
Southowram	W. H. D. Horsfall.
Sowerby Bridge	F. Rothera.
Stafford	W. Blackshaw.
Staffordshire (Highways)	J. Moncur.
Stamford	J. Richardson.
Stapleton	A. J. Saise.
Stockport	J. Atkinson.
Stockton	K. F. Campbell.
Stourbridge	W. Fiddian.
Strand	A. Ventris.
Stratford-on-Avon	R. Dixon.
Streatham	J. Barber.
Stretford	H. Royle.
Strood	W. Brooke.
Sunbury-on-Thames	H. F. Coales.
Suffolk (County), East	H. Miller.
Sunderland	R. S. Rounthwaite.
Surrey (County)	F. G. Howell.
Sussex (County), East	H. Card.
Sutton Coldfield	C. F. Marston.
Sutton-in-Ashfield	McW. Bishop.
Swanage	J. S. Senior.
Swansea	G. Bell.
,, (Rural)	J. Thomas.
Swinton	W. F. Pinfold.
„	H. Entwisle.
Sydney, N.S.W.	R. W. Richards.
Tamworth	H. J. Clarson.
Teddington	M. Hainsworth.
Teignmouth	C. Jones.
Tettenhall	J. Mortimer.
Tewkesbury, Gloucestershire	W. H. Gray.
Thornhill	S. W. Parker.
Tientsin, China	A. W. H. Bellingham.
Tipperary (County), South	E. A. Hackett.
Tipton	W. H. Jukes.
Todmorden	H. Shaw.
Tonbridge	F. Harris.
Tooting	J. Barber.
Toowong, Queensland	W. E. Irving.
Torquay	W. Ingham.
„	H. A. Garrett.
Tokio Fu, Japan	R. Hara.
„ „	Y. Kurata.
Tredegar	W. C. Widdowson.
Trowbridge	F. E. G. Bradshaw.
Tunbridge Wells	T. E. W. Mellor.
Tunstall	A. R. Wood.
Turton	J. Parkinson.
Twickenham	G. B. Laffan.
Tyldesley	J. B. Smith.
Tynemouth	J. F. Smillie.
Tyrone (County) North	F. J. Lynam.
,, ,, South	J. W. Leebody.
Upper Soothill	T. Fenn.

Ventnor	E. J. Harvey.
Victoria, Australia	J. C. Ross.
Wakefield	R. Porter.
„ (Rural)	F. Massie.
Walham Green	C. Botterill.
Wallasey	A. Salmon.
Walsall	R. H. Middleton.
Wallsend	G. Hollings.
Walthamstow	G. W. Holmes.
Walton-le-Dale	F. E. Dixon.
Wandsworth	P. Dodd.
Wanstead	J. T. Bressey.
Wantage	W. Hanson.
Ware	J. Goddard.
Warminster	W. Bayley.
Warwickshire (County)	J. Willmot.
Waterford	M. J. Fleming.
„ (County)	W. E. L. Duffin.
Waterloo, Liverpool	F. S. Yates.
Watford	D. Waterhouse.
„ (Rural)	G. A. Heath.
Wavertree	W. H. Travers.
Wednesbury	E. M. Scott.
Wellingborough	E. Sharman.
Wembley	C. L. Whitehead, jun.
West Bridgford	A. Smithies.
West Bromwich	A. D. Greatorex.
West Cowes	N. F. Dennis.
West Derby	F. C. Everett.
West Ham, London	L. Angell.
West Hartlepool	J. W. Brown.
Westminster (St. James')	H. Monson.
Westminster (St. Margaret and St. John)	G. R. W. Wheeler.
Weston-super-Mare	H. Nettleton.
Weymouth and Melcombe Regis	W. B. Morgan.
Whitechapel	J. A. P. Waddington.
Whitehaven	J. S. Brodie.
Widnes	J. S. Sinclair.
Willenhall	C. J. Jenkin.
Willesden	O. C. Robson.
Wimbledon	C. H. Cooper.
Wirksworth	A. R. Ridout.
Wisbech	A. H. Plowright.
Witham	A. M. Clarke.
Withington	A. H. Mountain.
Wolverhampton	J. W. Bradley.
Wood Green	C. J. Gunyon.
Woodford	C. Mathew.
Woollahra (Sydney)	J. J. Haycroft.
Worcester	T. Caink.
„ (County)	J. H. Garrett.
Worksop	T. Kidd.
„ (Rural)	W. T. Brown.
Wrexham	J. P. Evans.
„	J. W. M. Smith.
Yeadon	C. Lund.
Yeovil	W. K. L. Armytage.
York	A. Creer.
„ (Rural)	W. G. Penty.
Yorkshire (East Riding)	A. Beaumont.

DISTRICTS.

No. 1.—THE HOME DISTRICT.

Hon. Secretary—G. B. Laffan, Twickenham.

MEMBERS.

Acworth, A. B.	Town Surveyor, Milton-next-Sittingbourne, Kent.
Angell, J. A., A.M.Inst.C.E.	Surveyor to Urban District Council, Beckenham.
ANGELL, LEWIS, M. Inst. C.E. (*Past President and Treasurer*)	Borough Engineer, West Ham.
Aspinall, M., A.M.Inst.C.E.	Borough Surveyor, Ramsgate.
Baker, J., A. M. Inst. C.E...	Town Surveyor, Slough.
Banks, W., A. M. Inst. C.E.	City Surveyor, Rochester.
Barnes, S. W. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hanwell.
Bennett, W. B. G., Assoc. M. Inst. C.E.	Borough Surveyor, Southampton.
Binnie, A. R., M. Inst. C.E. (*Vice-President.*)	Chief Engineer, London County Council, Spring Gardens, S.W.
Bradford, J. H.	Borough Surveyor, Aylesbury.
Bressey, J. T.	Surveyor to the Urban District Council, Wanstead, Essex.
Bridges, O. A.	Borough Surveyor, Lymington.
Brierley, J. H.	Borough Surveyor, Richmond, Surrey.
Brooke, W., A.M. Inst. C.E.	Surveyor to the Rural District Council, Strood.
Bunting, T. F.	Borough Surveyor, Maidstone.
Butler, W.	Surveyor to the Urban District Council, Farcham.
Campbell, A. H.	City Surveyor, Canterbury.
Capon, E. R.	Surveyor to the Urban District Council, Epsom.
Card, H.	County Surveyor, Lewes.
Catt, A. J.	Surveyor to the Urban District Council, Sandwich.
Chadwick, J.	Surveyor to the Urban District Council, Penny Stratford.
Charles, T.	Surveyor to the Urban District Council, Harrow.
Chart, R. M.	Consulting Surveyor to the Rural District Council, Croydon.
Clark, F. D., A.M.Inst.C.E.	Borough Engineer, Reigate.
Clarke, A. M.	Surveyor to the Urban District Council, Witham.
Coales, H. F.	Surveyor to the Urban District Council, Sunbury-on-Thames.
Collins, R.	Surveyor to Urban District Council, Enfield, N.
Cooper, C. H., A.M.Inst.C.E.	Surveyor to Urban District Council, Wimbledon.
Copland, C. A.	Surveyor to Urban District Council, Sheerness.
Cregeen, H. S.	Consulting Surveyor to the Urban District Council, Bromley, Kent.
Crimp, W. Santo, M. Inst. C.E.	District Engineer, London County Council, Spring Gardens, S.W.
Davies, W. A., A.M. Inst. C.E.	Town Hall, Hounslow.

Dawson, C. J.	Surveyor to the Urban District Council, Barking.
Dawson, N. H.	Borough Surveyor, Banbury.
Dawson, W., M. Inst. C.E.	Surveyor to Urban District Council, Leyton, E.
DEACON, G. F., M.Inst.C.E. (*Past President.*)	32 Victoria Street, Westminster, S.W.
Dennis, N. F., A.M.Inst.C.E.	Town Surveyor, West Cowes.
Dewhirst, J.	Surveyor to Rural District Council, Guildford.
Ditcham, H.	Borough Surveyor, Harwich.
Dodd, P., Assoc. M. Inst. C.E.	Surveyor, Wandsworth, S.W.
Dunscombe, C., M.A., M. Inst. C.E.	20 Victoria Street, Westminster.
Ebbetts, D. J.	Surveyor to the Urban District Council, Acton.
ELLICE-CLARK, E. B., M. Inst. C.E. (*Past President*).	Late County Surveyor for Sussex (West). 32 Victoria Street, Westminster, S.W.
Evans, A. J. L.	Borough Surveyor, Luton.
Fairley, W., A.M.Inst.C.E.	Richmond Main Sewerage Board, Mortlake, S.W.
Felkin, H. R.	Surveyor to the Southall Norwood Urban Council.
Forder, W. G.	Sunnydale, Thornton Heath.
Franks, T. W., A.M.Inst.C.E.	Borough Surveyor, Lewes.
Frost, H.	Surveyor to the Urban District Council, Farnham.
Fry, W. H., A.M.Inst.C.E.	Surveyor to the Urban District Council, Alverstoke.
Gamble, S. G., Assoc. M. Inst. C.E.	Metropolitan Fire Brigade, Southwark Bridge Road.
Ginn, A. F.	District Surveyor to the Kent County Council, Tonbridge.
Gloyne, R. M., A.M.Inst.C.E.	Borough Surveyor, Eastbourne.
Goddard, J.	Surveyor to the Urban District Council, Ware.
Golder, T. C.	Borough Surveyor, Deal.
Graves, M. D.	Surveyor to Urban District Council, Bexhill.
Greatorex, A. D., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Sutton, Surrey.
Grimley, S. S., A.M.Inst.C.E.	Surveyor to Urban District Council, Hendon.
Gunyon, C. J., A.M.Inst.C.E.	Surveyor to Urban District Council, Wood Green.
Hainsworth, M.	Surveyor to Urban District Council, Teddington.
Hanson, W.	Surveyor to the Rural District Council, Wantage.
Harding, J.R., A.M.Inst.C.E.	Surveyor to the Urban District Council, Epsom, Surrey.
Harlock, H.	Borough Engineer, Southend-on-Sea.
Harris, F.	Surveyor to the Tonbridge Rural District Council.
Harvey, E. J.	Surveyor to Urban District Council, Ventnor.
Hawkings, S. T.	Surveyor to the Urban District Council, Bromley.
Heath, G. A.	Surveyor to Rural District Council, Watford.
Henderson, A. J.	Surveyor to the District Highway Board, Kingston.
Hind, H.	Surveyor to Urban District Council, Erith.
Hodson, G., M. Inst. C.E.	Loughborough.
Hogbin, L. W.	Surveyor to Rural District Council, Isle of Thanet.
Holmes, G. W.	Surveyor to Urban District Council, Walthamstow.
Hooper, J. D.	Consulting Surveyor to the Urban District Council, Woodford, Essex.
Hope, W. H.	Surveyor to Rural District Council, Kingston-on-Thames.
Howard, H.	Surveyor to the Urban District Council, Littlehampton.
Howell, F. G.	County Surveyor, Kingston-on-Thames.
Hurd, H.	Surveyor to Urban District Council, Broadstairs.
James, A. C.	Surveyor to the Urban District Council, Grays Thurrock.

Jameson, M. W.	Surveyor to the Urban District Council, South Hornsey.
Jevons, J. H.	Borough Surveyor, Hertford.
Jones, Lt.-Col. A. C., V. C., Assoc. M. Inst. C.E.	Ridge Cottage, Finchampstead, Berks.
JONES, C., M.Inst.C.E. (*Past Pres. and General Hon. Sec.*)	Surveyor to the Urban District Council, Ealing, Middlesex.
Kemp, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hampton, Middlesex.
Knapp, R. W.	Borough Surveyor, Christchurch.
Lacey, F. W., A.M.Inst.C.E.	Town Surveyor, Bournemouth.
Laffan, G. B., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Twickenham.
Latham, A., M. Inst. C.E. ..	Borough Engineer, Margate.
Laurens, F.	Surveyor to Rural District Council, Cookham.
Lawson, C. G., A.M.Inst.C.E.	Surveyor to Urban District Council, Southgate.
Leete, W. H., A.M.Inst.C.E.	County Surveyor, Bedford.
LEMON, J., M.Inst.C.E. (*Past President.*)	Consulting Engineer, Southampton.
Locke, W. R.	Surveyor to Urban District Council, Caversham.
Lockwood, P. C., M.Inst. C.E.	Late Borough Surveyor, Brighton, Sussex.
Lovegrove, E. J.	Surveyor to Urban District Council, Hornsey.
Lund, J.	Borough Surveyor, Bedford.
McKie, H. U., M. Inst. C.E.	11 Victoria Street, Westminster.
Maltby, F. T., A.M.Inst.C.E.	Borough Surveyor, Guildford.
Mann, J., Assoc. M. Inst. C.E.	Surveyor to Urban District Council, Sevenoaks.
Manning, G. W.	Surveyor to the Beds County Council, Biggleswade, Beds.
Mathew, C.	Surveyor to Urban District Council, Woodford.
Mathews, G. S., A.M.Inst.C.E.	Surveyor to the Urban District Council, Dorking.
May, F. J. C., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Brighton.
Mellor, T. E. W., Assoc. M. Inst. C.E.	Borough Surveyor, Tunbridge Wells.
Molineux, W. F. Y.	Surveyor to Rural District Council, New Winchester.
Murch, P.	Borough Engineer, Portsmouth.
Nankivell, H. H.	Surveyor to Urban District Council, Braintree.
Newman, F.	Borough Engineer, Ryde, and County Surveyor, Isle of Wight.
Palmer, F. W. J.	Surveyor to the Urban District Council, Herne Bay.
Pollard, J., Assoc. M. Inst. C.E.	Late Surveyor to the Urban District Council, Hendon. 7 Old Queen Street, Westminster.
Pratt, R.	Borough Surveyor, Henley-on-Thames.
Rapley, W., jun.	Surveyor to the Dorking Rural District Council.
Reynolds, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Friern Barnet.
Richards, H.	51 Grosvenor Road, S.W.
Richardson, R.	Surveyor to Urban District Council, Malton.
Robinson, J.	County Surveyor, Hampshire.
Robson, O. C., M. Inst. C.E. (*Vice-President.*)	Surveyor to the Urban District Council, Willesden, Middlesex.
Rooke, J. W. B., A. M. Inst. C.E.	Surveyor to the Urban District Council, Biggleswade.
Ruck, F. W.	County Surveyor, Kent, Maidstone.
Rushbrooke, T. J.	Borough Surveyor, High Wycombe.
Savage, W. H.	Surveyor to the Urban District Council, East Ham.
Scott, H. H., A. M. Inst. C.E.	Engineer to the Commissioners, Hove.
Scott, R. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Bishop's Stortford.

Sidwell, H. T.	Surveyor to the Blean Rural District Council, Herne, Canterbury.
Smith, I. C.	Surveyor to the Rural District Council, Chelmsford.
Smythe, F.	Surveyor to Urban District Council, Finchley, N.
Stallard, S.	Surveyor to Rural District Council, Maidstone.
Stevenson, J...	Surveyor to Urban District Council, East Molesey.
Stickland, E. A., Assoc. M. Inst. C.E.	Borough Surveyor, Newbury.
Stringfellow, H. W.	City Surveyor, Chichester.
Stringfellow, W.	Surveyor to the Urban District Council, East Cowes, Isle of Wight.
Terrill, W.	Surveyor to the Urban District Council, Ashford, Kent.
Thomas, R. J.	County Surveyor, Aylesbury.
Tomes, G. B.	Surveyor to the Barnes District Urban District Council.
Towlson, S.	Surveyor to the Urban District Council, Cheshunt.
Walker, T., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Croydon, Surrey.
Waterhouse, D.	Surveyor to the Urban District Council, Watford.
Watts, E. T...	Surveyor to the Rural District Council, Bishop's Stortford.
Weston, H. J., Assoc. M. Inst. C.E.	Late Surveyor to the Urban District Council, Shirley and Freemantle, Southampton.
White, J., A. M. Inst. C.E. ..	Borough Surveyor, Folkestone.
WHITE, W. H., M.Inst.C.E. (*Past President.*)	City Engineer, Oxford.
Whitehead, C. L.	Surveyor to Urban District Council, Wembley.
Wilson, R. A.	Surveyor to Urban District Council, Carshalton.
Winship, G., A. M. Inst. C.E.	Borough Surveyor, Abingdon, Berks.
Woodbridge, C. A.	Surveyor to the Hendon Union Rural District Council.
Worth, J. E., M. Inst. C.E...	District Engineer, London County Council, Spring Gardens, S.W.
York, H...	Surveyor to the Urban District Council, East Barnet Valley.

TOWNS.

Abingdon	G. Winship.
Acton	D. J. Ebbetts.
Alverstoke	W. H. Fry.
Aylesbury	J. H. Bradford.
„ (County)	R. J. Thomas.
Banbury	N. H. Dawson.
Barking	C. J. Dawson.
Barnes	G. B. Tomes.
Beckenham	J. A. Angell.
Bedford	J. Lund.
„ (County)	W. H Leete.
Bexhill	M. D. Graves.
Biggleswade	J. W. B. Rooke.
„ (County)	G. W. Manning.
Bishop's Stortford	R. S. Scott.
„ „ (Rural D.C.)	E. T. Watts.
Bleam (R.DC..)	H. T. Sidwell.

Braintree	H. H. Nankivell.
Brighton	F. J. C. May.
Broadstairs	H. Hurd.
Bromley	S. T. Hawkings.
Buckinghamshire (County)	R. J. Thomas.
Canterbury	A. H. Campbell.
Carshalton	R. A. Wilson.
Caversham	W. R. Locke.
Cheshunt	S. Towlson.
Chichester	H. W. Stringfellow.
Cookham	F. Laurens.
Christchurch	R. W. Knapp.
Croydon	T. Walker.
Deal	T. C. Golder.
Dorking	G. S. Mathews.
„ (Rural D.C.)	W. Rapley, jun.
Ealing	C. Jones.
East Barnet Valley	H. York.
East Cowes	W. Stringfellow.
East Ham	W. H. Savage.
East Molesey	J. Stevenson.
Eastbourne	R. M. Gloyne.
Enfield	R. Collins.
Epsom	E. R. Capon.
Erith	H. Hind.
Fareham	W. Butler.
Farnham	H. Frost.
Fenny Stratford	J. Chadwick.
Finchley	F. Smythe.
Folkestone	J. White.
Friern Barnet	E. J. Reynolds.
Grays Thurrock	A. C. James.
Guildford	J. Dewhirst.
„	F. T. Maltby.
Hampshire (County)	J. Robinson.
Hampton	J. Kemp.
Hanwell	S. W. J. Barnes.
Harrow	T. Charles.
Hendon	S. S. Grimley.
„ (Rural)	C. A. Woodbridge.
Henley-on-Thames	R. Pratt.
Herne Bay	F. W. J. Palmer.
Hertford	J. H. Jevons.
Heston and Isleworth	W. A. Davies.
High Wycombe	T. J. Rushbrooke.
Hornsey	E. J. Lovegrove.
Hove	H. H. Scott.
Isle of Thanet	L. W. Hogbin.
Kent (County)	F. W. Ruck.
Kingston (Highway Board)	A. J. Henderson.
„ (Rural)	W. H. Hope.
Lewes	T. W. Franks.
Leyton, E.	W. Dawson.
Littlehampton	H. Howard.
London (County)	A. R. Binnie.
„ „	J. E. Worth.
Luton	A. J. L. Evans.
Lymington	C. A. Bridges.
Maidstone (Rural)	S. Stallard.
Malton	R. Richardson.
Margate	A. Latham.
Milton-next-Sittingbourne	A. B. Acworth.

New Winchester (R.D.C.)	W. F. Y. Molineux.
Newbury	E. A. Stickland.
Oxford	W. H. White.
Portsmouth	P. Murch.
Ramsgate	M. Aspinall.
Reigate	F. D. Clark.
Richmond	J. H. Brierley.
Rochester	W. Banks.
Ryde	F. Newman.
Sandwich	A. J. Catt.
Sevenoaks	J. Mann.
Sheerness	C. A. Copland.
Slough	J. Baker.
South Hornsey	M. W. Jameson.
Southall Norwood	H. R. Felkin.
Southampton	W. B. G. Bennett.
Southend-on-Sea	P. Dodd.
„	H. Harlock.
Southgate	C. G. Lawson.
Sunbury-on-Thames	H. F. Coales.
Surrey (County)	F. G. Howell.
Sussex (County), East	Hy. Card.
Sutton	A. D. Greatorex.
Teddington	M. Hainsworth.
Tonbridge	A. F. Ginn.
„ (Rural)	F. Harris.
Tunbridge Wells	T. E. W. Mellor.
Twickenham	G. B. Laffan.
Ventnor	E. J. Harvey.
Walthamstow	G. W. Holmes.
Wanstead	J. T. Bressey.
Wantage	W. Hanson.
Ware	J. Goddard.
Watford	D. Waterhouse.
„ (Rural)	G. A. Heath.
Wembley	C. L. Whitehead.
West Cowes	N. F. Dennis.
West Ham, London	L. Angell.
Willesden	O. C. Robson.
Wimbledon	C. H. Cooper.
Witham	A. M. Clarke.
Wood Green	C. J. Gunyon.
Woodford	C. Mathew.

No. 2.—METROPOLITAN DISTRICT.

Hon. Secretary—G. R. W. Wheeler, Town Hall, Westminster, S.W.

MEMBERS.

Barber, J. P., A.M.Inst.C.E.	Vestry Surveyor, St. Mary, Islington.
Barratt, F. W.	Vestry Surveyor, Bethnal Green.
Blair, W. N., A.M.Inst.C.E.	Vestry Surveyor, St. Pancras.
Botterill, C.	Vestry Surveyor, Town Hall, Walham Green.
Burgess, S. E.	Vestry Surveyor, Stoke Newington.
Carline, J., A. M. Inst. C.E.	District Surveyor, Lewisham, Catford Hill, S.E.
Dixon, J. R.	Vestry Surveyor, Shoreditch.
Dodd, P., Assoc. M. Inst. C.E.	Surveyor, Wandsworth, S.W.
Findlay, R., A. M. Inst. C.E.	Surveyor to the Parish of Eltham, Plumstead.
Gow, W. C.	Vestry Surveyor, Vestry Hall, Plumstead.
Higgens, T. W. E., Assoc. M. Inst. C.E.	Vestry Surveyor, Chelsea.
Holt, G. F.	Late Surveyor, Poplar District Board of Works.
Iron, W.	Vestry Surveyor, Clerkenwell.
Isaacs, L. H.	Surveyor to the Holborn District Board of Works, Verulam Buildings, Gray's Inn Road.
Knight, J. M.	Vestry Surveyor, Vestry Hall, Mile End.
Livingstone, G., Assoc. M. Inst. C.E.	Vestry Surveyor, St. George, Hanover Square.
Lowe, C. H., M. Inst. C.E. (*Vice-President.*)	Vestry Surveyor, Hampstead.
Mair, H., Assoc. M. Inst. C.E.	Surveyor to the Parish of Hammersmith.
Marten, H. J., A.M.Inst.C.E.	Vestry Surveyor, Wandsworth (Streatham and Tooting).
Mason, C., Assoc. M. Inst. C.E.	Vestry Surveyor, St. Martin-in-the-Fields. Town Hall, Charing Cross, S.W.
Meaby, M. C., A.M.Inst.C.E.	Vestry Surveyor, St. Luke, Middlesex.
Monson, H.	Vestry Surveyor, St. James', Westminster.
Norrington, J. P., Assoc. M. Inst. C.E.	Vestry Surveyor, Lambeth Vestry Hall, Kennington Green.
Norrish, G. R.	Vestry Surveyor, St. Saviour, Southwark.
Oxtoby, W., A.M. Inst. C.E.	Surveyor to the Board of Works, Poplar.
Pilditch, J. T.	Vestry Surveyor, Battersea.
Radford, J. C., A.M.Inst.C.E.	District Surveyor, Putney.
Rowland J.	District Surveyor, Plumstead (Charlton Parish).
Scorgie, N., A.M. Inst. C.E.	Vestry Surveyor, Rotherhithe, S.E.
Southam, A., A.M. Inst. C.E.	Surveyor, Clapham, S.W.
Sumner, F., A.M. Inst. C.E.	Vestry Surveyor, Bermondsey.
Thompson, G. W., Assoc. M. Inst. C.E.	Vestry Surveyor, St. Olave, Southwark.
Tomkins, H., A.M. Inst. C.E.	Vestry Surveyor, St. Marylebone.
Ventris, A., A. M. Inst. C.E.	Surveyor to the Strand District Board of Works.
Waddington, J. A. P., Assoc. M. Inst. C.E.	Vestry Surveyor, Whitechapel.
Wallace, G.	Surveyor to St. Giles District Board of Works.
Weaver, W., M. Inst. C.E. (*Member of Council.*)	Vestry Surveyor, Kensington.

Weston, G.	Vestry Surveyor, Paddington.
Wheeler, G. R. W., Assoc. M. Inst. C.E. (*Member of Council.*)	Vestry Surveyor, Westminster. *Hon. Secretary*, Metropolitan District.
Winter, O. E., Assoc. M.Inst. C.E.	Vestry Surveyor, St. George the Martyr, Southwark.
Woods, H.	District Surveyor, Plumstead (Parishes of Lee and Kidbrook).

TOWNS.

Battersea	J. T. Pilditch.
Bermondsey	F. Sumner.
Bethnal Green	F. W. Barratt.
Chelsea	T. W. E. Higgens.
Clapham	A. Southam.
Clerkenwell	W. Iron.
Eltham	R. Findlay.
Fulham	C. Botterill.
Hammersmith	H. Mair.
Hampstead	C. H. Lowe.
Holborn	L. H. Isaacs.
Kensington	W. Weaver.
Lambeth	J. P. Norrington.
Lewisham	J. Carline.
Mile End	J. M. Knight.
Paddington	G. Weston.
Plumstead	W. C. Gow.
„ (Charlton)	J. Rowland.
„ (Eltham)	R. Findlay.
„ (Lee and Kidbrook) ..	H. Woods.
Poplar	W. Oxtoby.
Putney	J. C. Radford.
Rotherhithe	N. Scorgie.
St. George, Hanover Square	G. Livingstone.
St. George, Southwark	O. E. Winter.
St. Giles	G. Wallace.
St. Luke	M. C. Meaby.
St. Martin-in-the-Fields	C. Mason.
St. Mary, Islington	J. P. Barber.
St. Marylebone	H. Tomkins.
St. Olave, Southwark	G. W. Thompson.
St. Pancras	W. N. Blair.
St. Saviour, Southwark	G. R. Norrish.
Strand	A. Ventris.
Shoreditch	J. R. Dixon.
Wandsworth	P. Dodd.
„ (Streatham and Tooting)	H. J. Martin.
Westminster (St. James')	H. Monson.
„ (St. Margaret and St. John)	G. R. W. Wheeler.
Whitechapel	J. A. P. Waddington.

No. 3.—THE MIDLAND DISTRICT.

Hon. Secretary—A. T. Davis, Shire Hall, Shrewsbury.

MEMBERS.

Bailey, E.	Borough Surveyor, Leominster,
Baldwin, L. L.	Surveyor to the Urban District Council, Coalville, Leicester.
Baylis, T. P.	Borough Surveyor, Droitwich.
Beckley, J. W.	Town Surveyor, Brierley Hill.
Bettany, F.	Borough Engineer, Burslem.
Bishop, McW.	Surveyor to the Urban District Council, Sutton-in-Ashfield, Notts.
Blackshaw, W., A. M. Inst. C.E.	Borough Surveyor, Stafford.
Bradley, J. W.	Borough Engineer, Wolverhampton.
Brettell, W. H.	Surveyor to the Urban District Council, Rowley Regis, Staffordshire.
Brown, A., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Nottingham.
Brown, W. I.	Borough Surveyor, Northampton.
Brown, W. T.	Surveyor to the Rural District Council, Worksop.
Clarson, H. J.	Borough Surveyor, Tamworth.
Coales, H. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Market Harborough.
Comber, A.	Borough Surveyor, Kidderminster.
Cook, F. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Mansfield Woodhouse.
Cordon, R. C.	Surveyor to the Belper Rural District Council Duffield, Derby.
Currall, A. E.	Surveyor to the Rural District Council, Solihull, Warwickshire.
Davis, A. T., Assoc. M. Inst. C.E. (*Member of Council.*)	County Surveyor, Salop; *Hon. Secretary*, Midland Counties District.
Dixon, R.	Borough Surveyor, Stratford-on-Avon.
Dunscombe, N., A.M.I.C.E.	Borough Surveyor, Chesterfield.
EAYRS, J. T., M. Inst. C.E. (*Past President.*)	39 Corporation Street, Birmingham.
Eddowes, W. C.	Borough Surveyor, Shrewsbury.
Fiddian, W.	Town Surveyor, Stourbridge.
Gammage, J.	Borough Surveyor, Dudley.
Gammell, H. H.	Surveyor to Urban District Council, Perry Barr.
Garratt, C. T.	Surveyor to the Urban District Council, Ashby Woulds.
Garrett, J. H.	County Surveyor, Worcester.
Godfrey, R., Assoc. M. Inst. C.E. (*Member of Council.*)	
A. D. Greatorex, Assoc. M. Inst. C.E.	Borough Surveyor, West Bromwich.
Green, A. A.	Borough Surveyor, Brackley.
Griffiths, F.	Corporation Waterworks Engineer, Leicester.
Hamar, A.	Borough Surveyor, Bishop's Castle, Salop.
Hammonds, G. B.	Surveyor to the Urban District Council, Newport, Salop.

HARRISON, R. J., Assoc. M. Inst. C.E.	Borough Surveyor, Derby.
HAWLEY, G. W.	Surveyor to District Highway Board, Nottingham.
HERROD, H.	Surveyor to the Rural District Council, Barrow-on-Soar.
HOOLEY, E. P., Assoc. M. Inst. C.E. (*Member of Council.*)	County Surveyor, Nottingham.
HOWSE, W. T.	Surveyor to Urban District Council, Hinckley.
JAFFREY, W.	Town Surveyor, Matlock Bath.
JEEVES, E.	Surveyor to the Urban District Council, Melton Mowbray.
JENKIN, C. J.	Surveyor to Urban District Council, Willenhall.
JUKES, W. H...	Surveyor to the Urban District Council, Tipton.
KENNEDY, J. D.	Town Surveyor, Retford.
KIDD, T., Assoc. M. Inst. C.E.	Surveyor to Urban District Council, Worksop.
KILFORD, H. J.	Borough Surveyor, Ilkeston, Derbyshire.
KING, W...	Surveyor to Rural District Council, Blaby.
LAW, E.	County Surveyor, Northampton.
LILLEY, G. H.	Surveyor to the Urban District Council, Ashby-de-la-Zouch.
LOBLEY, J., M. Inst. C.E. (*Past President.*)	Borough Engineer, Hanley, Staffordshire.
MARSTON, C. F., Assoc. M. Inst. C.E.	Borough Surveyor, Sutton Coldfield.
MAWBEY, E. G., Assoc. M. Inst. C.E.	Borough Engineer, Leicester.
MAWSON, R. C.	Borough Surveyor, Evesham.
MIDDLETON, R. H...	Borough Surveyor, Walsall.
MONCUR, J.	Highway Surveyor, Staffordshire.
MORTIMER, J.	Surveyor to the Urban District Council, Tettenhall, near Wolverhampton.
MYATT, J.	Town Surveyor, Leek.
PARKER, J., A. M. Inst. C.E.	City Surveyor, Hereford.
PEMBERTON, O.	Surveyor to Urban District Council, Desborough.
PICKERING, J. S., A. M. Inst. C.E.	Surveyor to Urban District Council, Nuneaton.
PRICE, J., Assoc. M. Inst. C.E.	City Surveyor, Birmingham.
PRITCHARD, E., M. Inst. C.E. (*Past President*).	37 Waterloo Street, Birmingham.
PURNELL, E. J.	City Surveyor, Coventry, Warwickshire.
RIDOUT, A. R.	Surveyor to Urban District Council, Wirksworth.
ROGERS, W. E.	Surveyor to the Rugeley Urban District Council.
SCOTT, E. M.	Borough Surveyor, Wednesbury.
SHACKLETON, C. W.	Surveyor to the Urban District Council, Coseley.
SHARMAN, E.	Surveyor to the Urban District Council, Wellingborough, Northamptonshire.
SHAW, J. H.	Surveyor to the Urban District Council, Brownhills, Staffordshire.
SHEPHERD, G. J.	Highway Surveyor, Kidderminster.
SHEPPARD, G.	Borough Surveyor, Newark.
SHIPTON, T. H.	Surveyor to the Urban District Council, Oldbury.
SIMPSON, W. H., Assoc. M. Inst. C.E.	Late Surveyor to the Blaby Union Rural District Council, Leicester.
SMITH, T. R.	Surveyor to Urban District Council, Kettering.
SMITHIES, A.	Surveyor to the Urban District Council, West Bridgford.
STORY, J. S., M.Inst.C.E. ..	County Surveyor, Derby.
STUART, J. C.	Surveyor to Urban District Council, Smethwick.
TILL, W. S., M. Inst. C.E. (*Past President.*)	Consulting Engineer, Birmingham.
TULEY, W.	Surveyor to Urban District Council, Rothwell.
VALLANCE, R. F.	Town Surveyor, Mansfield.

Wakelam, H. T., Assoc. M. Inst. C.E.	County Surveyor, Hereford.
Walshaw, J. W.	Borough Surveyor, Peterborough.
Wardle, J. W., Assoc. M.Inst. C.E.	Borough Surveyor, Longton.
Whitbread, R.	Surveyor to the Urban District Council, Carlton, Notts.
Williams, J. B.	Borough Surveyor, Daventry.
Willmot, J.	County Surveyor, Warwickshire.
Wilson, C. L. N., Assoc. M. Inst. C.E.	Town Surveyor, Bilston.
Wood, A. R.	Surveyor to the Urban District Council, Tunstall.
Wynne-Roberts, R. O. ..	Borough Surveyor, Oswestry.

TOWNS.

Ashby-de-la-Zouch	G. H. Lilley.
Ashby Woulds	C. T. Garratt.
Aston	H. Richardson.
Barrow-on-Soar (R.D.C.)	H. Herrod.
Belper	R. C. Cordon.
Bilston	C. L. N. Wilson.
Birmingham	J. Price.
Bishop's Castle	A. Hamar.
Blaby	W. King.
Brackley	A. A. Green.
Brierley Hill	J. W. Beckley.
Brownhills	J. H. Shaw.
Bursлем	F. Bettany.
Carlton, Notts	R. Whitbread.
Chesterfield	N. Dunscombe.
Coalville	L. L. Baldwin.
Coseley	C. W. Shackleton.
Coventry	E. J. Purnell.
Daventry	J. B. Williams.
Derby	R. J. Harrison.
„ (County)	J. S. Story.
Desborough	O. Pemberton.
Droitwich	T. P. Baylis.
Dudley	J. Gammage.
Hanley	J. Lobley.
Hereford	J. Parker.
„ (County)	H. T. Wakelam.
Hinckley	W. T. Howse.
Ilkeston	H. J. Kilford.
Kettering	T. R. Smith.
Kidderminster	A. Comber.
„	G. J. Shepherd.
King's Norton (R.D.C.)	R. Godfrey.
Leek	J. Myatt.
Leicester	E. G. Mawbey.
Leominster	E. Bailey.
Longton	J. W. Wardle.
Mansfield	R. F. Vallance.
Mansfield Woodhouse	F. P. Cook.
Market Harborough	H. G. Coales.
Matlock Bath	W. Jaffrey.
Melton Mowbray	E. Jeeves.

Newark	G. Sheppard.
Newport, Salop	G. B. Hammonds.
Northampton	W. I. Brown.
„ (County)	E. Law.
Nottingham	A. Brown.
„ (County)	E. P. Hooley.
Nuneaton	J. S. Pickering.
Oldbury	T. H. Shipton.
Oswestry	R. O. W. Roberts.
Oundle	J. M. Siddons.
Perry Barr	H. H. Gammell.
Peterborough	J. W. Walshaw.
Retford	J. D. Kennedy.
Rothwell	W. Tuley.
Rowley Regis	W. H. Brettell.
Rugby	D. G. MacDonald.
Rugeley	W. E. Rogers.
Shrewsbury	W. C. Eddowes.
Shropshire (County)	A. T. Davis.
Smethwick	J. C. Stuart.
Solihull (Rural)	A. E. Currall.
Stafford	W. Blackshaw.
Staffordshire (Highways)	J. Moncur.
Stourbridge	W. Fiddian.
Stratford-on-Avon	R. Dixon.
Stretford	H. Royle.
Sutton Coldfield	C. F. Marston.
Sutton-in-Ashfield	McW. Bishop.
Tamworth	H. J. Clarson.
Tettenhall	J. Mortimer.
Tipton	W. H. Jukes.
Tunstall	A. R. Wood.
Walsall	R. H. Middleton.
Warwickshire	J. Willmot.
Wednesbury	E. M. Scott.
Wellingborough	E. Sharman.
West Bromwich, Staffordshire	A. D. Greatorex.
Willenhall	C. J. Jenkin.
Wolverhampton	R. E. W. Berrington.
Worcester (County)	J. H. Garrett.
Worksop	T. Kidd.
„ (Rural)	W. T. Brown.

No. 4.—THE YORKSHIRE DISTRICT.

Hon. Secretary—T. W. Stainthorpe, Eston.

MEMBERS.

Armistead, Richard, Assoc. M. Inst. C.E.	Surveyor to the Improvement Commissioners Bingley, Yorkshire.
Atkinson, W...	Surveyor to Rural District Council, Kiveton Park.
Baker, F.	Borough Surveyor, Middlesbrough.
Barras, C. C...	Surveyor to Rural District Council, Doncaster.
Beaumont, A.	County Surveyor, Yorkshire, East Riding.
Brown, R. R.	Surveyor to Urban District Council, Bridlington.
Cass, R. W.	Surveyor to the Urban District Council, Pudsey.
Cox, J. H., M. Inst. C.E. .. (*Member of Council.*)	Borough Surveyor, Town Hall, Bradford.
Crabtree, W. H. R., Assoc. M. Inst. C.E.	Borough Surveyor, Doncaster.
Creer, A., Assoc. M. Inst.C.E. (*Member of Council.*)	City Surveyor, York.
Dearden, H.	Borough Surveyor, Batley.
Dyer, S.	Late Surveyor to the Urban District Council, Bridlington.
Dyson, J. W.	Surveyor to the Rural District Council, Halifax (Clifton, Brighouse)
Edson, W.	City Surveyor, Ripon.
ESCOTT, E. R. S., M. Inst. C.E. (*President.*)	Borough Engineer, Halifax.
Farrington, W.	Surveyor to the Hoyland Nether Urban District Council.
Fenn, T.	Surveyor to the Urban District Council, Upper Soothill.
Gaskell, P.	Surveyor to the Urban District Council, Hornsea, near Hull.
Godfrey, B., Assoc. M. Inst. C.E.	Surveyor to Rural District Council, Rotherham.
Hare, F. H.	Surveyor to the Urban District Council, Mirfield.
Hewson, T., M. Inst. C.E. .. (*Member of Council.*)	Borough Engineer, Leeds.
Hopkinson, W. H...	Borough Engineer, Keighley.
Hopper, H. T.	Surveyor to the Urban District Council, North Ormesby, Middlesbrough.
Horsfall, W. H. D.	Surveyor to Urban District Council, Southowram.
Howcroft, J. (*Member of Council.*)	Surveyor, Kirkleatham Urban District Council, Redcar, Yorkshire; *Hon. Sec.*, Northern Counties District.
Jennings, G.	Borough Surveyor, Rotherham.
Lewis, J. D.	City Engineer's Office, Leeds.
Lund, C.	Surveyor to Urban District Council, Yeadon.
Mallinson, T.	Surveyor to the Urban District Council, Skipton.
Marks, H. C., A. M. Inst. C.E.	Borough Engineer, Dewsbury.
Massie, F., A. M. Inst. C.E.	Surveyor to Rural District Council, Wakefield.
Palliser, W. A.	Surveyor to Urban District Council, Ilkley.
Parker, S. W.	Surveyor to Urban District Council, Thornhill.
Pearson, W. T.	Surveyor to Urban District Council, Rothwell.
Penty, W. G.	Surveyor to the Rural District Council, York.

Porter, R.	Borough Surveyor, Wakefield.
Robinson, W. P.	Surveyor to the Urban District Council, Skelton-in-Cleveland.
Rodwell, A.	Surveyor to Rural District Council, Skipton.
Ross, P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, North Bierley, Bradford.
Rothera, F.	Surveyor to the Urban District Council, Sowerby Bridge.
Saville, J.	Town Surveyor, Heckmondwike.
Spinks, W., Assoc. M. Inst. C.E.	52 Prudential Assurance Buildings, Park Row, Leeds.
Stainthorpe, T.W., A.M.Inst. C.E. (*Member of Council.*)	Surveyor to the Eston Urban District Council, Yorkshire; *Hon. Sec.*, Yorkshire District.
Stead, S..	Borough Surveyor, Harrogate.
Sutcliffe, A...	Surveyor to Urban District Council, Featherstone.
Tarbit, T. H.	Surveyor to the Urban District Council, Loftus, Yorks.
Trow, S.	Surveyor to the Urban District Council, Otley.
Wetherill, J. W.	Surveyor to Urban District Council, Rawmarsh.
Wike, C. F., M. Inst. C.E. .. (*Member of Council.*)	Borough Engineer, Sheffield.

TOWNS.

Batley	H. Dearden.
Bingley	R. Armistead.
Bradford	J. H. Cox.
Bridlington	R. R. Brown.
Dewsbury	H. C. Marks.
Doncaster	W. H. R. Crabtree.
„ (Rural)	C. C. Barras.
Eston District	T. W. Stainthorpe.
Evesham	R. C. Mawson.
Featherstone	A. Sutcliffe.
Halifax	E. R. S. Escott.
Harrogate	S. Stead.
Heckmondwike	J. Saville.
Hornsea	P. Gaskell.
Hoyland Nether	W. Farrington.
Hull	A. E. White.
Ilkley	W. A. Palliser.
Keighley	W. H. Hopkinson.
Kirkleatham	J. Howcroft.
Kiveton Park	W. Atkinson.
Leeds	T. Hewson.
Loftus	T. H. Tarbit.
Middlesbrough	F. Baker.
Mirfield	F. H. Hare.
North Bierley	P. Ross.
North Ormesby	H. T. Hopper.
Otley	S. Trow.
Pudsey	R. W. Cass.
Rawmarsh	J. W. Wetherill.
Ripon	W. Edson.
Rotherham	G. Jennings.
„	B. Godfrey.
Rothwell	W. T. Pearson.
Sheffield	C. F. Wike.
Skelton-in-Cleveland	W. P. Robinson.
Skipton	T. Mallinson.
„	A. Rodwell.

Southowram	W. H. D. Horsfall.
Sowerby Bridge	F. Rothera.
Thornhill	S. W. Parker.
Todmorden	H. Shaw.
Wakefield	R. Porter.
„ (Rural)	F. Massie.
West Hartlepool	J. W. Brown.
Worksop (R.D.C.)	W. T. Brown.
Yeadon	C. Lund.
York	A. Creer.
„ (Rural)	W. G. Penty.
Yorkshire (County), East Riding ..	A. Beaumont.

No. 5.—THE LANCASHIRE AND CHESHIRE DISTRICT.

Hon. Secretary—F. S. Button, Town Hall, Burnley.

MEMBERS.

Adshead, E. E.	Borough Surveyor, Macclesfield.
Atkinson, J., A. M. Inst. C.E.	Borough Surveyor, Stockport.
Ball, B., Assoc. M. Inst. C.E.	Borough Engineer, Nelson.
BOULNOIS, H. P., M. Inst. C.E. (*Past President.*)	City Engineer, Liverpool.
Brierley, R.	Town Surveyor, Newton-in-Makerfield, Lancashire.
Brockbank, W. H.	Borough Surveyor, Bolton.
Brooke, J.	Surveyor to Urban District Council, Northwich.
Broom, G. J. C., M. Inst. C.E.	Borough Engineer, St. Helen's, Lancashire.
Brownridge, C., Assoc. M. Inst. C.E.	Borough Engineer, Birkenhead.
Burslam, R.	Borough Surveyor, Congleton.
Burton, J. H...	Surveyor to the Urban District Council, Audenshaw, Lancashire.
Button, F. S., Assoc. M. Inst. C.E. (*Member of Council.*)	Late Borough Surveyor, Burnley; *Hon. Secretary*, Lancashire and Cheshire District.
Calvert, W.	Surveyor to the Urban District Council, Hebden Bridge.
CARTWRIGHT, J., M. Inst. C.E. (*Past President.*)	Borough Surveyor, Bury, Lancashire.
Clough, W.	Surveyor to Urban District Council, Atherton.
Cook, J., Assoc. M. Inst. C.E.	Borough Surveyor, Lancaster.
Crowther, J. A.	Borough Surveyor, Bootle, Lancashire.
Dent, William	Late Surveyor to the Urban District Council, Nelson-in-Marsden, Lancashire. Railway Street, Nelson.
Diggle, J., A. M. Inst. C.E...	Borough Engineer, Heywood.
Diggle, Wm.	Surveyor, Frodsham, Chester.
Dixon, F. E., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Walton-le-Dale.

Earnshaw, J. T., Assoc. M. Inst. C.E.	Borough Surveyor, Ashton-under-Lyne, Lancashire.
Eaton-Shore, G., Assoc. M. Inst. C.E.	Borough Surveyor, Crewe.
Eckersley, W.	Surveyor to the Urban District Council, Chadderton, Lancashire.
Edmundson, S.	Surveyor to Rural District Council, Burnley.
Entwisle, H	Surveyor to the Urban District Council, Swinton.
Everett, F. C., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, West Derby.
Foster, T.	Surveyor to the Hoylake and West Kirby Urban District Council.
FOWLER, ALFRED M., M.Inst.C.E. (*Past President*).	St. Peter's Square, Manchester. 35 Old Queen Street, Westminster, S.W.
Fraser, A. O...	Surveyor to the Urban District Council, Allerton, Liverpool.
Gaulter, M. S.	Town Surveyor, Fleetwood.
Goldsworth, W.	Surveyor to the Urban District Council, Prescot, Lancashire.
Greenwood, A.	Late Surveyor to the Urban District Council, Todmorden.
Gregson, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Padiham, near Burnley.
Hall, W., Assoc.M.Inst.C.E.	Surveyor to Urban District Council, Great Crosby.
Hartley, T. H.	Borough Surveyor, Colne.
Heaton, G., Assoc. M. Inst. C.E.	Surveyor to Urban District Councils, Pemberton, Aspull, Abram, and Orrell. King Street, Wigan.
Higginson, T.	28 Deacon Road, Appleton, Widnes.
Hooley, Cosmo C., Assoc. M. Inst. C.E.	Rural District Council, Barton-upon-Irwell, Patricroft; Urban District Council, Urmston, near Manchester.
Jepson, J.	Surveyor to Urban District Council, Levenshulme.
Jones, I. M., Assoc. M. Inst. C.E.	City Surveyor, Chester; Engineer to the Dee Bridge Commissioners.
Kay, W. R.	Surveyor to the Urban District Council, Irlam.
Landless, J. T.	Surveyor to the Urban District Council, Brierfield, Lancashire.
Leigh, W.	Borough Surveyor, Chorley.
McBeath, A. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Sale, Cheshire.
McKenzie, J. McD.	Surveyor to the Rural District Council, Bucklow.
Mawson, J.	Late Surveyor to the Urban District Council, Shaw, near Oldham.
MEADE, T. DE COURCY, M.Inst.C.E. (*Past President.*)	City Surveyor, Manchester.
Mills, J. H.	Surveyor to the Urban District Council, Crompton, near Oldham.
Mitchell, J.	Borough Surveyor, Hyde, Manchester.
Mountain, A. H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Withington, near Manchester.
Naylor, W., A. M. Inst. C.E.	16 Walton's Parade, Preston.
Newton, G. H.	Surveyor to the Urban District Council, Denton, Manchester.
Newton, J., M. Inst. C.E. ..	Engineer to the Urban District Council, Bowdon, Cheshire.
Newton, W. J., Assoc. M. Inst. C.E.	Borough Surveyor, Accrington.
Nuttall, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Councils, Kearsley and Ramsbottom, Lancashire.
Parkinson, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Turton, near Bolton.
Pickering, S. A.	Borough Surveyor, Oldham.

Pickles, G. H.	Borough Surveyor, Burnley.
Platt, S. S., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Rochdale.
Proctor, J., M. Inst. C.E. ..	13 Mawdesley Street, Bolton, Lancashire.
Rothwell, E., Assoc. M. Inst. C.E.	Springfield Cottage, Marland, Rochdale.
Royle, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Stretford, Lancashire.
Salmon, A., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Wallasey, Cheshire.
Shaw, H., Assoc. M. Inst. C.E.	Surveyor to Urban District Council, Todmorden.
Sheard, W. C.	Surveyor to the Urban District Council, Heaton Norris.
Sinclair, J. S., A.M.Inst.C.E.	Borough Surveyor, Widnes.
Smith, C. C.	Surveyor to the Urban District Council, Dalton-in-Furness.
Smith, J. B.	Surveyor to Urban District Council, Tyldesley.
Spinks, W., Assoc. M. Inst. C.E.	Late Surveyor to the Urban District Council, Dukinfield. 9 Albert Square, Manchester.
Stokoe, J.	Surveyor to Urban District Council, Altrincham.
Stubbs, Wm., A. M. Inst. C.E.	Borough Engineer, Blackburn.
Swarbrick, J., Assoc. M. Inst. C.E.	33 Brasenose Street, Albert Square, Manchester.
Sykes, E., Assoc. M. Inst. C.E.	Late Surveyor to the Urban District Council, Cheadle, Manchester.
Taylor, R.	Borough Surveyor, Haslingden.
Thorburn, T. C.	Late Borough Surveyor, Birkenhead.
Thorpe, J.	Surveyor to Rural District Council, Macclesfield.
Travers, W. H.	Surveyor to Urban District Council, Wavertree.
Turley, A. C.	Borough Engineer, Eccles.
Veevers, H., A. M. Inst. C.E.	Surveyor to Urban District Council, Dukinfiel l.
Watts, W.	Water Engineer, Oldham.
Webster, R. J.	Surveyor to Urban District Council, Castleton
Welburn, W.	Borough Surveyor, Middleton, near Manchester.
Wild, G. H.	Surveyor to Urban District Council, Littleborough, near Manchester.
Wilding, J.	Surveyor to the Urban District Council, Runcorn.
Wilson, J.	Borough Surveyor, Bacup, Lancashire.
Window, E. R., Assoc. M. Inst. C.E.	Late Surveyor to the Urban District Council, Bishop's Stortford. 16 Cook Street, Liverpool.
Yates, F. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Waterloo, near Liverpool.

TOWNS.

Abram	Geo. Heaton.
Accrington	W. J. Newton.
Allerton	A. O. Fraser.
Altrincham	J. Stokoe.
Ashton-under-Lyne	J. T. Earnshaw.
Aspull	Geo. Heaton.
Atherton	W. Clough.
Audenshaw	J. H. Burton.

Bacup	J. Wilson.
Barton-upon-Irwell (Rural)	C. C. Hooley.
Birkenhead	C. Brownridge.
Blackburn	W. Stubbs.
Bolton	W. H. Brockbank.
Bootle	J. A. Crowther.
Bowdon	J. Newton.
Brierfield	J. T. Landless.
Bucklow	J. McD. McKenzie.
Burnley	G. H. Pickles.
„ (Rural)	S Edmondson.
Bury	J. Cartwright.
Castleton	R. J. Webster.
Chadderton	W. Eckersley.
Chester	I. M. Jones.
Chorley	W. Leigh.
Colne	T. H. Hartley.
Congleton	R. Burslam.
Crewe	G. Eaton-Shore.
Crompton	J. H. Mills.
Dalton-in-Furness	C. C. Smith.
Denton	G. H. Newton.
Dukinfield	H. Veevers.
Eccles	A. C. Turley.
Fleetwood	M. S. Gaulter.
Frodsham	W. Diggle.
Great Crosby	W. Hall.
Haslingden	R. Taylor.
Heaton Norris	W. C. Sheard.
Hebden Bridge	W. Calvert.
Heywood	J. Diggle.
Hoylake and West Kirby	T. Foster.
Hyde	J. Mitchell.
Irlam	W. R. Kay.
Kearsley	T. Nuttall.
Lancaster	J. Cook.
Levenshulme	J. Jepson.
Littleborough	G. H. Wild.
Liverpool	H. P. Boulnois.
Macclesfield	E. E. Adshead.
„ (Rural)	J. Thorpe.
Manchester	T. de C. Meade.
Middleton, Lancashire	W. Welburn.
Nelson	B. Ball.
Newton-in-Makerfield	R. Brierley.
Northwich	J. Brooke.
Oldham	S. A. Pickering.
„	W. Watts.
Orrell	G. Heaton.
Padiham	J. Gregson.
Pemberton	G. Heaton.
Prescot	W. Goldsworth.
Ramsbottom	T. Nuttall.
Rochdale	S. S. Platt.
Runcorn	J. Wilding.
Sale	A. G. McBeath.
St. Helen's	G. J. C. Broom.
Stockport	J. Atkinson.
Swinton	H. Entwisle.
Turton	J. Parkinson.
Tyldesley	J. B. Smith.

Wallasey	A. Salmon.
Walton-le-Dale	F. E. Dixon.
Waterloo, Liverpool	F. S. Yates.
Wavertree	W. H. Travers.
West Derby	F. C. Everett.
Widnes	J. S. Sinclair.
Withington	A. H. Mountain.

No. 6.—THE WESTERN DISTRICT.

Hon. Secretary—Joseph Hall, Town Hall, Cheltenham.

MEMBERS.

Armytage, W. K. L.	Borough Surveyor, Yeovil.
ASHMEAD, F., M. Inst. C.E. (*Past President*).	"Glenthorn," Alma Vale Road, Clifton, Bristol.
Bayley, W. T. S., Assoc. M. Inst. C.E.	Surveyor to Urban District Council, Warminster.
Bennett, H. M.	Surveyor to the Rural District Council, Keynsham, Bristol.
Beswick, W. H.	Surveyor to Urban District Council, Exmouth.
Bradshaw, F. E. G.	Surveyor to Urban District Council, Trowbridge.
Cainк, T., Assoc. M. Inst. C.E.	City Engineer, Worcester.
Cameron, D.	City Surveyor, Exeter.
Cotterell, A. P. I., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Horfield.
Debnam, A. W.	Surveyor to the Urban District Council, East Stonehouse.
Edinger, P.	Surveyor to the Urban District Council, Frome.
Elford, J.	Borough Surveyor, Poole.
Farrall, T.	Surveyor to the Urban District Council, Sherborne, Dorset.
Flower, J. M.	Surveyor to the Urban District Council, Portishead, near Bristol.
Garrett, H., A. M. Inst. C.E.	Town Surveyor, Torquay.
Geen, H.	Borough Surveyor, Okehampton.
Gray, W. H.	Borough Surveyor, Tewkesbury, Gloucestershire.
Greenwell, A.	Surveyor to the Rural District Council, Frome.
Hall, J., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Cheltenham; *Hon. Secretary*, Western Counties District.
Hawkins, I. T.	Town Surveyor, Somerton, Somersetshire.
Haynes, R. H.	Borough Engineer, Newport, Mon.
Hickes, T. J.	County Surveyor, Cornwall (Western division), Truro.

Hodge, J. L., Assoc. M. Inst. C.E.	Late Surveyor to the Urban District Council, East Stonehouse, Devon.
Hunt, G. J.	Borough Surveyor, Dorchester.
Ingham, W.	Water Engineer, Torquay.
Jones, C...	Surveyor to Urban District Council, Teignmouth.
Kirby, C., Assoc. M. Inst. C.E.	Water Engineer, Newport, Mon.
Knowles, G. W.	Town Surveyor, Clevedon, Somerset.
Lewis, T. L.	Surveyor to Urban District Council, St. George, Bristol.
Morgan, W. B., Assoc. M. Inst. C.E.	Borough Surveyor, Weymouth, and Melcombe Regis, Dorchester.
Nettleton, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Weston-super-Mare.
Parr, F.	Borough Surveyor, Bridgwater.
Paton, J.	Borough Engineer, Plymouth.
Phillips, R.	County Surveyor, Gloucester.
Powell, D. H. W...	Surveyor to the Urban District Council, Kingswood, near Bristol.
Press, W. J.	Surveyor to the Urban District Council, Burnham, Somerset.
Prouse, O. M., A.M.Inst.C.E.	Surveyor to Urban District Council, Ilfracombe.
Read, R., Assoc. M. Inst. C.E.	City Surveyor, Gloucester.
Sadler, G. W.	Late Surveyor to the Rural District Council, 467 High Street, Cheltenham.
Saise, A. J.	Surveyor to the Urban District Council, Stapleton, Bristol.
Senior, J. S.	Surveyor to Urban District Council, Swanage.
Stevens, G.	Surveyor to Urban District Council, Blaina, Mon.
Stevens, L.	Surveyor to the Urban District Council, Newton Abbott, Devon.
Tanner, W.	County Surveyor, Monmouthshire. Newport.
Webster, J. L.	Surveyor to the Urban District Council, Portland.
Widdowson, W. C.	Surveyor to Urban District Council, Tredegar, Mon.
Wyatt, W. J...	Surveyor to the Urban District Council, Paignton, Devon.
Yabbicom, T. H., A. M. Inst. C.E.	City Engineer, Bristol.

TOWNS.

Abergavenny	J. Haigh.
Blaina	G. Stevens.
Bournemouth	F. W. Lacey.
Bridgwater	F. Parr.
Bristol	T. H. Yabbicom.
„ (Rural)	H. M. Bennett.
Burnham, Somerset	W. J. Press.
Cheltenham	J. Hall.
Clevedon	G. W. Knowles.
Cornwall (County), West	T. J. Hickes.
Dorchester	G. J. Hunt.
East Stonehouse	A. W. Debnam.
Exeter	D. Cameron.
Exmouth	W. H. Beswick.
Frome	P. Edinger.
„ (Rural)	A. Greenwell.

Gloucester	R. Read.
„ (County)	R. Phillips.
Horfield	A. P. I. Cotterell.
Ilfracombe	O. M. Prouse.
Kingswood	D. H. W. Powell.
Monmouthshire (County)	W. Tanner.
Newton Abbott	L. Stevens.
Newport, Mon.	R. H. Haynes.
Okehampton	H. Geen.
Paignton	W. J. Wyatt.
Plymouth	J. Paton.
Poole	J. Elford.
Portishead	J. Moss Flower.
Portland	J. L. Webster.
St. George, Bristol	T. L. Lewis.
Sherborne	T. Farrall.
Somerton	I. T. Hawkins.
Swanage	J. S. Senior.
Teignmouth	C. Jones.
Tewkesbury, Gloucestershire	W. H. Gray.
Torquay	H. A. Garrett.
„	W. Ingham.
Tredegar	W. C. Widdowson.
Trowbridge	F. E. G. Bradshaw.
Warminster	W. Bayley.
Weston-super-Mare	H. Nettleton.
Weymouth and Melcombe Regis ..	W. B. Morgan.
Worcester	T. Caink.
Yeovil	W. K. L. Armytage.

No. 7.—THE NORTHERN DISTRICT.

Hon. Secretary—JAS. HOWCROFT, Redcar.

MEMBERS.

AITKEN, T.	County Surveyor, Cupar, Fife.
ANDERSON, R. S., Assoc. M. Inst. C.E.	County Surveyor, Peebles, N.B.
BEATSON, W.	Borough Surveyor, Leith.
BOWER, J.	Borough Engineer, Gateshead-on-Tyne.
BRODIE, J. S., A.M. Inst. C.E.	Town Surveyor, Whitehaven.
BROWN, J. W., A.M. Inst. C.E.	Borough Engineer, West Hartlepool.
CAMPBELL, K. F., Assoc. M. Inst. C.E.	Borough Surveyor, Stockton.
COOPER, J., Assoc.M.Inst.C.E.	Burgh Engineer, Edinburgh.
COOPER, W. W.	Surveyor to Urban District Council, Bedlington.
CRUMMACK, H. C., Assoc. M. Inst. C.E.	Borough Surveyor, Hartlepool.
CURRY, W. F...	Surveyor to the Urban District Council, Morpeth.
DALTON, J. P.	Surveyor to the Urban District Council, Ryton-on-Tyne.
DICKINSON, R.	Borough Surveyor, Berwick-on-Tweed.
DYACK, W., Assoc.M.Inst.C.E.	Burgh Surveyor, Aberdeen.
GODDARD, G. C.	Borough Surveyor, Kendal.
GREGSON, G.	Surveyor to the Rural District Council, Durham.
GRIEVES, R.	Surveyor to the Cowpen Urban District Council, Blyth.
HALL, M.	Borough Surveyor, South Shields, Durham.
HODGSON, W.	Surveyor to the Urban District Council, Keswick.
HOLLINGS, G...	Surveyor to the Urban District Council, Wallsend.
LAWS, W. G., M. Inst. C.E. (*Past President.*)	City Engineer, Newcastle-on-Tyne.
MASON, W. A.	Surveyor to the Urban District Council, Shildon, near Darlington.
PATTISON, W. P.	Surveyor to the Urban District Council, Benwell.
PETREE, J.	Borough Surveyor, Jarrow.
PICKERING, R.	11 Lowther Street, Whitehaven.
ROUNTHWAITE, R. S.	Borough Engineer, Sunderland.
SMILLIE, J. F.	Borough Surveyor, Tynemouth.
SMITH, W. H., Assoc. M. Inst. C.E.	City Engineer, Carlisle.
SPENCER, J. P., Assoc. M. Inst. C.E.	32 Moseley Street, Newcastle-on-Tyne.
TAYLOR, H. W.	Surveyor to Urban District Council, Newburn-on-Tyne.
TURNBULL, A. J.	Borough Engineer, Greenock.
WATSON, J. D., A.M.Inst.C.E.	County Sanitary Engineer, Aberdeenshire.
WAYE, H.	Surveyor to the Urban District Council, Millom, Cumberland.
WILSON, G.	Surveyor to the Urban District Council, Alnwick.
WILSON, J. B	Surveyor to the Rural District Council, Cockermouth.

TOWNS.

Aberdeen	W. Dyack.
Aberdeenshire	J. D. Watson.
Alnwick	G. Wilson.
Ayrshire	A. Stevenson.
Bedlington	W. W. Cooper.
Benwell	W. P. Pattison.
Berwick-on-Tweed	R. Dickinson.
Carlisle	W. H. Smith.
Cockermouth (R.D.C.)	J. B. Wilson.
Cowpen	W. Grieves.
Cupar	T. Aitken.
Durham (R.D.C.)	G. Gregson.
Edinburgh	J. Cooper.
Greenock	A. J. Turnbull.
Hartlepool	R. C. Crummack.
Jarrow	J. Petree.
Kendal	D. C. Goddard.
Keswick	W. Hodgson.
Leith	W. Beatson.
Millom	H. Waye.
Morpeth	W. F. Curry.
Newburn-on-Tyne	H. W. Taylor.
Newcastle-on-Tyne	W. G. Laws.
Peebles	R. S. Anderson.
Ryton-on-Tyne	J. P. Dalton.
Shildon	W. A. Mason.
South Shields	M. Hall.
Stapleton	A. J. Saise.
Stockton	K. P. Campbell.
Sunderland	R. S. Rounthwaite.
Tynemouth	J. F. Smillie.
Wallsend	G. Hollings.
Whitehaven	J. S. Brodie.

No. 8.—THE EASTERN DISTRICT.

Hon. Secretary—J. W. Cockrill, Great Yarmouth.

MEMBERS.

Bland, D.	Surveyor to the Urban District Council, Chesterton, Cambridge.
Boden, G.	Surveyor to the Rural District Council, Romford.
Buckham, F., M. Inst. C.E.. (*Member of Council.*)	Borough Surveyor, Ipswich.
Clare, J...	Surveyor to the Urban District Council, Sleaford.
Cockrill, J. W., Assoc.M.Inst. C.E. (*Member of Council.*)	Borough Surveyor, Great Yarmouth; *Hon. Secretary*, Eastern Counties District.
Cockrill, T., A. M. Inst. C.E.	Surveyor to Urban District Council, Haverhill, Suffolk.
Collins, A. E., A.M.Inst.C.E.	City Engineer, Norwich.
Evans, J...	Borough Surveyor, Grantham.
Goodyear, H., A. M.Inst.C.E.	Borough Surveyor, Colchester.
Hamby, G. H...	Borough Engineer, Lowestoft.
Himson, H. G.	Surveyor to the Urban District Council, East Dereham.
Horton, G. S.	Surveyor to Urban District Council, Felixstowe.
Keywood, H. G.	Surveyor to Rural District Council, Maldon.
Lacey, G. W.	Borough Surveyor, Saffron Walden.
MacBrair, R. A., Assoc. M. Inst. C.E.	City Engineer, Lincoln.
Metcalf, J. W., A.M.Inst.C.E.	Town Surveyor, Newmarket.
Miller, H.	County Surveyor, East Suffolk, Ipswich.
Moore, G. J.	City Surveyor, Wisbech.
Petree, M.	Borough Surveyor, Great Grimsby.
Plowright, A. H...	Borough Surveyor, Wisbech, Cambs.
Richardson, J.	Surveyor to Urban District Council, Stamford.
Riley, H.	Surveyor to the Rural District Council, Gainsborough.
Robinson, A. R.	Surveyor to the Urban District Council, Clacton-on-Sea.
Rowland, T.	Borough Engineer, Louth, Lincolnshire.
Rush, J.	Borough Surveyor, Eye, Suffolk.
Rushton, E.	Surveyor to the Urban District Council, Cleethorpes.
Sasse, G. H.	Borough Surveyor, Chelmsford.
Scott, A. F.	Surveyor to the Urban District Council, Cromer.
Silcock, E. J., A.M.Inst.C.E.	Borough Surveyor, King's Lynn.
Smith, J. C., A. M. Inst. C.E.	Borough Surveyor, Bury St. Edmunds.
Tooley, H.	Surveyor to Urban District Council, Buckhurst Hill.
White, A. E., A.M. Inst. C.E.	Borough Engineer, Hull.

TOWNS

Bury St. Edmunds	J. C. Smith.
Chelmsford	G. H. Sasse.
„ (R.D.C.)	I. C. Smith.
Chesterton	D. Bland.
Clacton-on-Sea	A. R. Robinson.
Cleethorpes	E. Rushton.
Colchester	H. Goodyear.
Cromer	F. A. Scott.
East Dereham	H. G. Himson.
Eye	J. Rush.
Felixstowe	G. S. Horton.
Gainsborough	H. Riley.
Grantham, Lincolnshire	J. Evans.
Great Grimsby	M. Petree.
Great Yarmouth	J. W. Cockrill.
Harwich	H. Ditcham.
Haverhill	T. Cockrill.
Ipswich	E. Buckham.
Isle of Ely (County)	G. J. Moore.
King's Lynn	E. J. Silcock.
Lincoln	R. A. MacBrair.
Louth	T. Rowland.
Lowestoft	G. H. Hamby.
Maldon	H. G. Keywood.
Newmarket	J. W. Metcalf.
„	H. W. Taylor.
Norwich	A. E. Collins.
Romford	G. Boden.
Saffron Walden	G. W. Lacey.
Sleaford	J. Clare.
Stamford	J. Richardson.
Suffolk (County), East	H. Miller.
Suffolk „ West	F. Whitmore.
Wisbech	A. H. Plowright

No. 9.—THE DISTRICT OF WALES.

Hon. Secretaries { (North)—J. W. M. Smith, Town Hall, Wrexham.
(South)—W. E. C. Thomas, Neath.

MEMBERS.

Bell, Geo.	Borough Surveyor, Swansea.
Bennett, C. G.	Surveyor to Urban District Council, Oystermouth.
Blackburn, T.	Surveyor to Urban District Council, Barmouth. North Wales.
Cooke, E.	Surveyor to Urban District Council, Abersychan.
Coverley, J. S.	Surveyor to the Urban District Council, Penmaenmawr.
Davies, R.	Borough Surveyor, Brecknock.
Davies, R. W.	Surveyor to Urban District Council, Newtown.
Evans, E. I.	Surveyor to the Urban District Council, Penarth, S. Wales.
Evans, J. P.	Surveyor to the Rural District Council, Wrexham.
Farrington, T. B.	Borough Engineer, Conway.
Fraser, W., A. M. Inst. C.E.	Surveyor to the Rural District Council, Cardiff.
Haigh, J., A. M. Inst. C.E. ..	Town Surveyor, Abergavenny.
Harpur, W., M. Inst. C.E. ..	Borough Surveyor, Cardiff.
Harvey, T. F., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Merthyr Tydvil.
Holden, J.	Surveyor to the Rural District Council, Llandaff.
Howell, J.	Surveyor to Urban District Council, Glyncorrwg.
Jones, J.	Surveyor to the Rural District Council, Merthyr Tydvil.
Jones, J. O.	Borough Surveyor, Pwllheli.
Jones, R.	Borough Surveyor, Aberystwyth.
Jones, W.	Surveyor to Urban District Council, Colwyn Bay.
Marks, T. T., Assoc. M. Inst. C.E.	Late Town Surveyor, Llandudno, Carnarvonshire.
Maybury, H. P.	Surveyor to Urban District Council, Festiniog.
Morgan, G. S.	Surveyor to Rural District Council, Llantrissant.
Morgan, J.	Surveyor to the Pontardawe Rural District Council, Swansea.
Pardoe, J. C.	Surveyor to the Barry and Cadoxton Urban District Council.
Smith, J. W. M. (*Member of Council.*)	Borough Surveyor, Wrexham, Denbighshire; *Hon. Secretary*, Wales District (North).
Stephenson, E. P.	Town Surveyor, Llandudno.
Stevens, G.	Surveyor to Urban District Council, Abercarne.
Thomas, J., A. M. Inst. C.E.	Surveyor to Rural District Council, Swansea.
Thomas, T. J., A.M.Inst.C.E.	Surveyor to Urban District Council, Ebbw Vale.
Thomas, W.	Late Surveyor to the Margam Urban District Council, Port-Talbot, S. Wales.
Thomas, W. E. C., A. M. Inst. C.E. (*Member of Council.*)	Surveyor to the Rural District Council, Neath. *Hon. Secretary*, Wales District (South).
Watkeys, G.	Surveyor to the Urban District Council, Llanelly.
Williams, H. D.	Surveyor to the Urban District Council, Ogmore and Garrw.
Williams, J.	Surveyor to Urban District Council, Mountain Ash.

TOWNS.

Abercarne	G. Stevens.
Abersychan	E. Cooke.
Aberystwyth	R. Jones.
Barmouth	T. Blackburn.
Barry and Cadoxton	J. E. Pardoe.
Brecknock	R. Davies.
Cardiff	W. Harpur.
„ (Rural)	W. Fraser.
Colwyn Bay	W. Jones.
Conway	T. B. Farrington.
Ebbw Vale	T. J. Thomas.
Glyncorrwg	J. Howell.
Llandaff	J. Holden.
Llandudno	E. P. Stephenson.
Llanelly	G. Watkeys.
Llantrissant	G. S. Morgan.
Merthyr Tydvil	T. F. Harvey.
„ „ (R.D.C.)	J. Jones.
Mountain Ash	J. Williams.
Neath (R.D.C.)	W. E. C. Thomas.
Newtown	R. W. Davies.
Ogmore and Garrw	H. D. Williams.
Oystermouth	C. G. Bennett.
Penarth	E. I. Evans.
Penmaenmawr	J. S. Coverley.
Pontardawe (Rural)	J. Morgan.
Pwllheli	J. O. Jones.
Swansea	G. Bell.
„ (Rural)	J. Thomas.
Wrexham	J. P. Evans.
„	J. W. M. Smith.

No. 10.—THE IRISH DISTRICT.

Hon. Secretary—R. H. Dorman, Armagh.

MEMBERS.

Bretland, J. C., M. Inst. C.E.	City Surveyor, Belfast.
Brett, J. H.	County Surveyor, Co. Antrim, Belfast, Ireland.
Burden, A.M., A.M.Inst.C.E.	County Surveyor, Kilkenny.
Christie, J.	City Electrical Engineer, Londonderry.
Collen, W., M.A., B.E., Assoc. M. Inst. C.E.	County Surveyor, Dublin (South).
Comber, P. F., M. Inst. C.E.I.	Town Surveyor, Bray.
Cowan, P. C., M. Inst. C.E. ..	County Surveyor, Down.
Dixon, E. K., M.E., M. Inst. C.E.	County Surveyor, Castlebar, South Mayo.
Dorman, R. H., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Armagh; *Hon. Secretary*, Irish District.

Duffin, W. E. L., M. Inst. C.E.I.	County Surveyor, Co. Waterford.
Fleming, M. J.	Borough Surveyor, Waterford.
Glover, E., M.A., B.E., M. Inst. C.E.	County Surveyor, Co. Kildare.
Gray, R. A.	County Surveyor, Dublin.
Gunnis, J. W...	County Surveyor, Co. Longford.
Hackett, E. A., M.E., M. Inst. C.E.	County Surveyor, South Tipperary.
Harty, S., M. Inst. C.E.I. ..	City Engineer, Dublin.
Heron, J.	County Surveyor, Co. Monaghan.
Horan, J., M.E., M. Inst. C.E.	County Surveyor, Co. Limerick.
Jackson, N.	County Surveyor, Co. Cork (West Riding), Bandon, Co. Cork.
Kirkby, S. A., M.A. (Cantab.)	County Surveyor, Co. Cork. Miramur, Queenstown.
Leebody, J. W.	County Surveyor, Co. Tyrone (S.)
Longfield, R. W. F.	County Surveyor, Co. Donegal (S.)
Lynam, F. J.	County Surveyor, Co. Tyrone (N.)
Lynam, P. J.	County Surveyor, Louth. Dundalk, Ireland.
Lyons, A. O., M. Inst. C.E. ..	County Surveyor, Co. Cork (East).
Moore, J. H.	County Surveyor, Meath.
Orchard, W. P., B.E.	County Surveyor, Ballina, North Mayo, Ireland.
Ottley, D. G., M. Inst. C.E.	County Surveyor, Co. Leitrim.
Perry, J., M.E., M. Inst. C.E.	County Surveyor, Galway (W. Riding).
Robinson, W. J., Assoc. M. Inst. C.E.	City Surveyor, Londonderry.
Sanders, R. B.	County Surveyor, King's County.
Shillington, H.	Town Surveyor, Lurgan.
Smith, J., A. M. Inst. C.E. ..	County Surveyor, Co. Galway (East Riding). Ballinasloe.
Somerville, R. N., B.E. ..	County Surveyor, Cavan, Ireland.
White, H. V., M. Inst. C.E. I.	County Surveyor, Queen's Co. Portarlington.
Willson, F. R. T.	County Surveyor, Co. Fermanagh.

TOWNS.

Antrim (County)	J. H. Brett.
Armagh (County)	R. H. Dorman.
Belfast	J. C. Bretland.
Bray	P. F. Comber.
Castlebar	E. K. Dixon.
Cavan (County)	R. N. Somerville.
Cork (County)	N. Jackson.
„ „	S. A. Kirkby.
„ „	A. O. Lyons.
Donegal (County), South	R. W. F. Longfield.
Down (County)	P. C. Cowan.
Dublin	S. Harty.
„ (County)	R. A. Gray.
„ „ South	W. Collen.
Fermanagh (County)	F. R. T. Willson.
Galway (County), E. Riding	J. Smith.
„ „ W. Riding	J. Perry.
Kildare (County)..	E. Glover.
Kilkenny (County)	A. M. Burden.
King's County	R. B. Sanders.

Leitrim (County)	D. G. Ottley.
Limerick (County)	J. Horan.
Londonderry	W. J. Robinson.
„	J. Christie.
Longford (County)	J. W. Gunnis.
Louth (County)	P. J. Lynam.
Lurgan	H. Shillington.
Meath (County)	J. H. Moore.
Monaghan (County)	J. Heron.
North Mayo (County)	W. P. Orchard.
North Tipperary	J. O. Moynan.
Queen's County	H. V. White.
South Tipperary	E. A. Hackett.
Tyrone (County), North	F. J. Lynam.
„ „ South	J. W. Leebody.
Waterford	M. J. Fleming.
„ (County)	W. E. L. Duffin.

No. 11.—ABROAD.

Hon. Corresponding Secretary—C. Mayne, Shanghai.

MEMBERS.

Abrahams, C. V.	City Surveyor, Kingston, Jamaica.
Aburrow, C., A. M. Inst. C.E.	Town Engineer, Johannesberg, S.A.
Andrews, G. R.	Waterworks Engineer, Johannesberg.
Bellingham, A. W. H., A.M. Inst. C.E.	Municipal Engineer, Tientsin, China.
Brown, P. H., A.M.Inst.C.E.	District Engineer, Godaveri, Madras.
Cairncross, T. W.	Waterworks Engineer, Cape Town, S.A.
Cooper, F. A., M. Inst. C.E.	Director of Public Works, Hong Kong.
Deverell, T. C., Assoc. M. Inst. C.E.	Melbourne, Victoria.
Ellis, R. E., A. M. Inst. C.E.	Engineer to the Municipality, Madras.
Hara, R.	Engineer to Tokio Fu, Japan.
Haycroft, J. J.	Borough Engineer, Woollahra, Sydney.
Irving, W. E.	Surveyor to the Municipal Shire of Toowong, near Brisbane, Queensland.
Kirk, T., A. M. Inst. C.E. ..	Brisbane, Queensland.
Kurata, Y.	Engineer to Tokio Fu, Japan.
Mayne, C.	Engineer and Surveyor, Municipal Council, Shanghai; *Hon. Corresponding Sec.*, Eastern Asia.
Murzban, M. C., C.I.E., A.M. Inst. C.E.	Municipal Engineer, Bombay.

Peirce, R.	Municipal Engineer, Penang, Straits Settlements.
Richards, R. W.	City Surveyor, Sydney, N.S.W.
Ross, J.	Town Engineer, Warrnambool, Victoria, Australia.
Skelton R., A. M. Inst. C. E.	Municipal Engineer, Colombo, Ceylon.
Stirrat, J.	Municipal Engineer, Rangoon.
Strachan, J.	Municipal Engineer, Kurachi.

TOWNS.

Bombay	M. C. Murzban.
Brisbane, Queensland	T. Kirk.
Colombo	R. Skelton.
Godaveri, Madras	P. H. Brown.
Hong Kong	F. A. Cooper.
Johannesberg	C. Aburrow. G. R. Andrews.
Kingston, Jamaica	C. V. Abrahams.
Kurachi	J. Strachan.
Madras	R. E. Ellis.
Melbourne	T. C. Deverell.
Penang, Straits Settlements	R. Peirce.
Rangoon	J. Stirrat.
Shanghai, China	C. Mayne.
Sydney (N.S.W.)	R. W. Richards.
Tientsin	A. W. H. Bellingham.
Tokio Fu (Japan)	R. Hara.
„ „ „	Y. Kurata.
Toowong, Queensland	W. E. Irving.
Warrnambool (Australia)	J. C. Ross.
Woollahra (Sydney)	J. J. Haycroft.

GRADUATES.

Angel, R. J.	Assistant Borough Surveyor, Town Hall, Walsall.
Armstrong, J. G. D.	H.M. Office of Works, Hanley.
Ball, C. F., A.M. Inst. C.E.	City Engineer's Office, Bristol.
Ball, Geo.	Borough Surveyor's Office, Scarborough.
Ball, J. B.	Great Northern Railway, King's Cross.
Bayley, G. H., A.M.Inst.C.E.	Craybrow, Lymm, Warrington.
Birch, J. E. W.	52 Heigham Road, East Ham, E.
Blizard, J. H., A.M.Inst.C.E.	Lansdowne House, Southampton.
Bradshaw, H. G.	Assistant Surveyor, Bacup.
Bradshaw, J. B.	R. E. Office, Gravesend.
Brown, R.	Urban District Council Offices, Ealing.
Bruce, W.	Borough Engineer's Office, Edinburgh.
Bryans, J. G.	Assistant Engineer, Buenos Ayres and Pacific Railway, Junin, Argentine.
Bryning, W. G.	County Surveyor's Department, Preston.
Burton, A., jun.	Town Hall, Hanley.
Carter, G. F., A.M.Inst.C.E.	City Engineer's Office, Leeds.
Catchpole, J. H.	27 Avenue Villas, Avenue Road, Finchley, N.
Chasemore, A. E.	"Eberbach," Oxford Road, Putney.
Claypoole, A. H., A. M. Inst. C.E.	City Surveyor's Office, Manchester.
Clegg, H.	Burgh Surveyor's Office, Aberdeen.
Corrie, H. W.	Borough Engineer's Office, Birkenhead.
Cross, F. W., A.M. Inst. C.E.	The Bridge, Walsall.
Crow, A...	51 Great Prescot Street, E.
Dolamore, F...	Borough Engineer's Office, Bournemouth.
Fell, P. O.	City Engineer's Office, Norwich.
Fenton, W. C.	Borough Surveyor's Office, Sheffield.
Finch, A. R., A.M. Inst. C.E.	Town Hall, Kensington.
Finglah, F. J.	Town Hall, Hounslow.
Fitton, G.	Borough Surveyor, Basingstoke.
Forbes, A. H.	Surveyor to the Urban District Council, Chesham, Bucks.
Fox, Senior L.	Soothill Hall, near Batley.
Franck-Clark, A. H.	Midland Railway Construction Works, Morecambe.
Gibbs, L., Assoc. M. Inst. C.E.	Surveyor's Office, P.W.D., Hong Kong.
Glass, S. N.	41 Old Queen Street, Westminster.
Gordon, J., A.M. Inst. C.E.	Borough Surveyor's Office, Aberdeen.
Greenwood, J. P.	Barry and Cadoxton Urban District Council, Cadoxton, near Cardiff.
Hellawell, O.	Town Hall, Withington, Manchester.
Hendry, J. S.	Town Hall, West Bromwich.
Hills, H. J.	86 College Road, Camden Town, N.W.
Hills, O. C.	147 Bow Road, E.
Horne, B.	The Parade, Sutton Coldfield.
Houghton, J.	King's Heath, Birmingham.

Jenkins, A. J.	Town Hall, Rochdale.
Julian, J.	Borough Surveyor's Office, Cambridge.
Kieser, W. H. G.	Town Hall, Torquay.
Killick, W. H.	Borough Surveyor's Office, Southampton.
Kirk, J. W.	Town Hall, Westminster.
Liversedge, J. W.	Rookery Villa, Fitzwilliam Street, Huddersfield.
Lobley, F. J.	City Engineer's Office, Norwich.
Lynam, G. T., A. M. Inst. C.E.	Assistant Burgh Surveyor, Aberdeen.
Manley, J.	Resident Engineer, Sewage Works, Buckingham.
Martin, E. B.	City Engineer's Office, Leeds.
Maxwell, W. H.	Town Hall, Leyton.
Newton, E. B.	City Surveyor's Office, Carlisle.
Nichols, A. E., A.M.Inst C.E.	City Engineer's Office, Leeds.
Nickols, F. J.	City Surveyor's Office, Carlisle.
Nightingale, C. F.	36 Bradford Street, Walsall.
Openshaw, J., A.M.Inst.C.E.	City Surveyor's Office, Sheffield.
Perkins, J.	85 Willows Road, Balsall Heath, Birmingham.
Perkins, T. L.	51 Prince Street, Bristol.
Price, A. J.	City Engineer's Office, Worcester.
Pritchard, T., A.M.Inst.C.E.	264 Gresham House, Old Broad Street, E.C.
Putman, W. E , A.M.Inst.C.E.	City Engineer's Office, Leeds.
Roberts, F.	Borough Engineer's Office, Birkenhead.
Saunders, J.	Borough Surveyor's Office, Oldham.
Savage, E. B.	City Engineer's Office, Norwich.
Settle, J. A.	Borough Surveyor's Office, Bolton.
Smith-Saville, R. W., Assoc. M. Inst. C.E.	Borough Surveyor's Office, Burton-on-Trent.
Steele, W. J.	Assistant Engineer, Tottenham.
Taylor, W. J., A.M.Inst.C.E.	1 Rose Road, Southampton.
Thackeray, F.	43 Richmond Terrace, Darwen.
Veit, L. J.	Town Hall, Wolverhampton.
Videan, H. N.	Assistant Borough Surveyor, Folkestone.
Ward, F. D., A. M. Inst. C.E.	3 Cobden Street, Welshpool.
Williams, D. S.	Woodland Villa, Mountain Ash.
Worrall, F.	Borough Surveyor's Office, Leicester.
Wright, J. A.	Lonsdale Chambers, Baldwin Street, Bristol.
Yarwood, Hy.	Town Hall, Rochdale.
Young, W.	Town Hall, Salford.

PARLIAMENTARY COMMITTEE.

O. C. Robson, *Chairman.*

Lewis Angell (West Ham).
R. Godfrey (King's Norton).
Chas. Jones (Ealing).
C. H. Lowe (Hampstead).
T. Walker (Croydon)
W. Weaver (Kensington).

BYE-LAWS.

Membership.

1. Members, Graduates, and Honorary Members of the existing Association may, upon signing and forwarding to the Secretary a claim according to Form F in the Appendix, become Members, Graduates, or Honorary Members respectively of the Association, without election or payment of entrance fees.

Members.

2. Candidates for admission as Members must be Civil Engineers or Surveyors holding chief permanent appointments under any Municipal Corporations, County Councils, or Urban or Rural Sanitary Authorities, and Civil Engineers or Surveyors holding other chief permanent appointments under any Public Authority of the like nature within the United Kingdom, or in the Colonies or foreign countries.

Graduates.

3. Candidates for admission as Graduates must be successful in obtaining certificates of competency at any examination under the auspices of the Association, and who are not otherwise qualified as Members of the Association; and as such shall be entitled to attend the General and District Meetings, and to take part in the proceedings thereof, and be entitled to a copy of the Minutes of Proceedings, but shall not be entitled to vote. Graduates shall at their request become Members of the Association when qualified according to Bye-law 2.

Honorary Members.

4. The Council shall have the power to elect as Honorary Members gentlemen of eminent scientific position or acquirements, who in their opinion are eligible for that position.

5. The Members, Graduates, and Honorary Members shall have notice of and the privilege to attend all Meetings, and be entitled to a copy of the Proceedings of the Association as published.

Entrance Fees and Subscriptions.

6. An Entrance Fee of One Guinea shall be paid by each Member, except Members of the existing Association, who shall pay

no Entrance Fee. Each Member shall pay an Annual Subscription of One Guinea.

7. A Graduate shall not be required to pay an Entrance Fee, either on his becoming a Graduate or on his becoming a Member. Each Graduate shall pay an Annual Subscription of Half a Guinea.

8. All Subscriptions shall be payable in advance, and shall become due on the 1st day of May in each year; and Members elected between the 1st day of January and the 1st day of May in each year are required to pay an Entrance Fee on Election, their first Subscription being due on the 1st day of May following their Election.

9. The Council may at their discretion reduce or remit the Annual Subscription, or the Arrears of Annual Subscription, of any Member who shall have been a Subscribing Member of the Association for ten years, and shall have become unable to continue the Annual Subscription provided by these Bye-laws.

10. No Proceedings or Ballot Lists shall be sent to Members or Graduates who are in arrear with their Subscriptions more than twelve months, and whose Subscriptions shall not have been remitted by the Council as hereinbefore provided.

Election of Members and Graduates.

11. A recommendation for admission according to Form A for a Member, and Form B for a Graduate, in the Appendix, shall be forwarded to the Secretary, and by him be laid before the next Meeting of the Council.

The recommendation must be signed by not less than Two Members, who from personal knowledge of such Candidate shall certify that he possesses the necessary qualification. Candidates residing outside England and Wales not known by two Members of this Association, may be proposed by three Corporate Members of the Institution of Civil Engineers. Members who cease to hold their appointments are eligible for re-election by the Council, but will be disqualified from holding any Office.

All Elections of Members and Graduates of the Association shall be made by the Council, and shall be decided by a majority of votes of the Members of the Council present and voting.

12. When the proposed Candidate is elected, the Secretary shall give him notice thereof according to Form C; but his name shall not be added to the List of Members or Graduates of the Association until he shall have paid his Entrance Fee and First Annual Subscription as defined by these Bye-laws.

13. A qualified Graduate desirous of becoming a Member shall forward to the Secretary a recommendation according to Form D

in the Appendix, signed by not less than two Members, which shall be laid before the next meeting of the Council for their approval. On their approval being given, the Secretary shall notify the same to the Candidate according to Form E. A Graduate on becoming qualified to be a Member shall cease to be a Graduate.

Election of President, Vice-Presidents, and Members of Council.

14. The Council shall nominate one name for President, six for Vice-Presidents, one for Honorary Secretary, and fifteen for Ordinary Members of Council. In addition to these, each Member of the Association shall be at liberty to nominate one Member for the Council, but in the event of the last named nominations exceeding fifteen, the Council shall reduce them to that number, so as to leave thirty names in all from which to elect the required number of Ordinary Members of Council. Members' nominations must be in the hands of the Secretary on or before the 20th of April in each year. And in case the Members' nominations should not reach fifteen, the Council shall have the power to make up the total number of nominations to twenty. Such list of twenty nominations shall be printed and sent to each Member of the Association not less than fourteen days previous to the Annual Meeting. Each Member shall be entitled to vote for or erase any of such Nominations or substitute other names, subject in all cases to the limits of Clause 25 in the Articles of Association, and return the same within seven days from the date of issue. Such Ballot Papers shall be examined in London by the President, Secretaries, and two Scrutineers appointed at the previous Annual Meeting, or by any two of the aforesaid Members. Any Member canvassing for votes for the office of Member of Council shall be considered ineligible for Election.

Appointment and Duties of Officers.

15. The Treasurer shall hold the uninvested funds of the Association, except the moneys in the hands of the Secretary for current expenses. He shall be appointed by the Members at a General or Special Meeting, and shall hold office at the pleasure of the Council.

16. The Secretary of the Association shall be appointed by the Council, and shall be removable by the Council upon three months' notice from any day. The Secretary, if desirous of resigning his appointment, shall give the same notice. The remuneration of the Secretary shall from time to time be fixed by the Council.

17. It shall be the duty of the Secretary, under the direction of the Council, to conduct the correspondence of the Association; to attend all General and Special Meetings of the Association and of the Council, and of Committees (but not the District Meetings, unless required so to do by the President); to take minutes of the proceedings of such meetings; to read the minutes of the preceding meetings, and all communications that he may be ordered to read; to superintend the publication of such papers as the Council may direct; to direct the collection of the subscriptions, and the preparation of the account of expenditure of the funds; and to present all accounts to the Council for inspection and approval, and generally to do all such other matters as usually pertain to the office of Secretary, or as may be prescribed by the Council.

Examinations.

18. Two examinations of Candidates for certificates of competency in Municipal Engineering, Surveying, Building Construction, Sanitary Science, and the Public Health Acts, shall be held annually at such places and at such times as the Council shall appoint.

The Board of Examiners shall be 12 in number, and shall be elected by and be Members of the Council, or such other Members of the Association as shall be leading men in their particular branch of the Engineering profession. Four of such Board shall be selected by the Council to carry out each Examination, who as "Acting Examiners," shall report to the Council the names of those Candidates who have satisfied them of their proficiency.

Miscellaneous.

19. All communications to the meetings shall be the property of the Association, and be published only by the authority of the Council.

20. Seven clear days' notice at least shall be given of every meeting of the Council. Such notice shall specify generally the business to be transacted by the meeting.

21. The Council shall present the yearly accounts to the Members at the Annual General Meeting, after being audited by two auditors, who shall be appointed annually by the Members at their Annual General Meeting.

THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

TWENTY-THIRD ANNUAL MEETING.

BRIGHTON, *June* 25, 26 *and* 27, 1896.

THE Members assembled in the Music Room of the Royal Pavilion, Brighton, the use of which had been kindly granted by the Mayor and Corporation.

The Mayor of Brighton (Mr. Alderman J. G. Blaker, J.P.), opened the proceedings by offering to the Association a very hearty welcome to Brighton.

The President, Mr. E. R. S. Escott, M. Inst. C.E., on behalf of the Association, thanked the Mayor for the kind welcome offered them.

The Secretary read the Minutes of the last Annual General Meeting, which were confirmed and signed.

The Secretary read the Council's Annual Report.

ANNUAL REPORT.

In meeting the Association at the commencement of its twenty-third year, the Council have to express their gratification at the progress which has been made during the past twelve months.

DISTRICT MEETINGS.

Since the last General Meeting, held in Halifax on June 27, 28 and 29, 1895, the following District Meetings have been held. At Londonderry and Portrush, on August 23 and 24, 1895; at Westminster, on February 21, and March 11, 1896; at King's

Heath, on March 28; at Mortlake and Twickenham, on May 30; and at Hanley, on June 13.

Roll of the Association.

During the financial year ending 30th April last, 79 New Members, consisting of 1 Honorary Member, 63 Ordinary Members, and 15 Graduates, have joined the Association. One Honorary Member, 2 Members, and 1 Graduate have resigned, 13 names have been written off, and the Council record with regret the death of Mr. W. Crabtree, of Southport.

The number on the Roll of the Association at the close of the year was 9 Honorary, 614 Ordinary Members, and 77 Graduates, making a total of 700, an addition equivalent to 8 per cent. on the numbers of the preceding year. The Council have transferred Messrs. B. Ball, S. Pickering and G. H. Pickles from the class of Graduates to that of Members, these gentlemen having been elected to appointments qualifying them for this class under the Articles of Association.

Mr. Schuurman, the Director of Works and Chief Engineer of the City of Amsterdam, having resigned his official position, the Council have, upon Mr. Schuurman's proposition, elected his successor, Mr. C. L. M. Lambrechtsen van Ritthem, upon the list of Honorary Members of the Association.

Finances.

The audited Balance Sheet and Statement of Accounts which accompany this report show a balance in hand on April 30 of 164*l.* 5*s.* 5*d.* During the year the capital account of the Association was augmented by the investment of 213*l.* in Southampton Corporation 3½ per cent. Stock. The accounts show that the financial position continues satisfactory, and the increase of invested capital gives further proof of the steady advancement of the Association.

Award of Premium.

The Council have awarded the premium of 10*l.* to Mr. James Paton, Borough Engineer, Plymouth, for his paper entitled "Plymouth and its Municipal Works," read at the Western Counties District Meeting held in that town on May 17 and 18, 1895.

Examinations.

Since the last Report two examinations have been carried out, the first of which was held at the Town Hall, Manchester, the use of which was kindly granted by the Corporation of that city, on October 4 and 5, 1895. On this occasion 12 candidates were examined: 6 satisfied the examiners and were granted the Association's certificate. The examiners were Messrs. Eayrs, Lemon, Meade and Pritchard. The second examination was held on April 10 and 11, 1896, at the Institution of Civil Engineers, Westminster, by kind permission, when 23 candidates were examined, of whom 11 satisfied the examiners and were also granted their certificates. The examiners were Messrs. Crimp, Eayrs, Lemon and Lobley. The number of candidates entered for these examinations steadily increasing each year, tends to prove increased public confidence in this branch of the work of the Association, and the Council trust that all Members will use their influence with their various Councils to recognise these examinations to their full value.

New Council.

The Ballot Lists having been duly issued, the Scrutineers report the result of the voting for the new Council as follows:—

President—Francis J. C. May.

Vice-Presidents—E. Buckham, C. H. Lowe and O. C. Robson.

Ordinary Members of Council—J. P. Barber, A. R. Binnie, J. H. Cox, A. Creer, A. T. Davis, R. Godfrey, W. Harpur, E. P. Hooley, E. G. Mawbey, S. S. Platt, W. Weaver and C. F. Wike.

General Honorary Secretary—C. Jones.

Treasurer—L. Angell.

Instructions for the Preparation of Papers.

With the view of aiding the Members in the preparation of papers, and at the same time to place before intending contributors the very great importance of delivering their communications to the Secretary in sufficient time to allow for examination, printing and distribution before the meeting, the Council have prepared and

issued to the Members full instructions upon this subject. It is hoped that Members will on their part do their best to comply with the instructions so given, in order to facilitate the general work of the meetings, and to obviate the complaints of Members being unable to obtain copies of papers before the meetings.

New Form of Application.

In consequence of a widespread opinion that the form of application for candidates for admission as Members of this Association did not meet the requirements, nor convey to the Council sufficient information for their guidance in the consideration of applications for membership, a new Form has, after careful consideration, been decided upon, by which a *résumé* of the professional career of the candidates will be set forth; and it is confidently expected that the effect will be beneficial to the status of the Association.

New Seal.

In reference to the designs for the new seal of the Association mentioned in the Council's last Annual Report, the Council after due consideration have awarded the premium to Mr. W. Oxtoby, then Borough Surveyor of Ramsgate, now the Surveyor of the Poplar Board of Works; the design sent by him being considered the most appropriate. The new seal was first utilised in May 1896, for the sealing of the certificates of the successful candidates in the examination of April last.

Members Ceasing to hold Appointments.

As an apparent ambiguity appeared to exist as to that portion of Rule 11 which refers to the position of Members who cease to hold their public appointments, the matter was brought under the notice of the Council and received careful consideration. Several alterations in the Rule were suggested to meet the case, but it was ultimately decided to leave the Rule as it at present stands, the Council dealing with individual cases as they occur. A note calling attention to the matter is now added to the Association's receipt.

Co-operation of Associations—Superannuation.

At the invitation of the Municipal Officers' Association, Messrs. Jones, Lowe and Robson attended, as delegates representing this Association, conferences at which the question of superannuation of officers was discussed. Ultimately it was decided that the Bill then before Parliament dealing with Poor Law Officers' Superannuation should not be endangered, but that its success should be availed of in the future, either by the individual action of the various societies representing municipal officers, or by a combination of such societies, having in view the superannuation of all municipal officers. The matter is being watched by your Parliamentary Committee, and representations have been made to other societies urging joint action in this matter, which is of such vital importance to all municipal engineers.

Suggested Amendments to Metropolis Local Management Acts.

At the Metropolitan District Meeting referred to previously in this Report, an important paper was read by Mr. Barber, dealing with some suggested amendments to the Metropolis Local Management Acts, resulting in a committee of Members of this Association being appointed to go into the suggestions made in the paper and to report thereon. It is considered that several more suggestions may thus be made, and the whole matter is now under the consideration of the said committee.

"Sewers" and "Drains."

A Bill to amend the interpretation of the words "Sewer" and "Drain" under the Public Health Act is being promoted in Parliament, and there appears a fair prospect that it may pass into law during the present session, and it is thereby hoped that this much vexed question will be thus finally settled to the advantage of local authorities throughout the kingdom.

Visitors to the Meetings.

The Council have felt that some action should be taken to regulate the attendance at Meetings of the Association of persons not being Members thereof, and they have accordingly decided that in future any Member desirous of introducing to the meetings a visitor, other than members of the public authority of the place where the meeting is held, shall, with the concurrence of the President for the time being, be provided with a card of admission bearing the visitor's name and signed by the Member introducing such visitor, and countersigned by the Secretary or the District Secretary.

Chas. Jones, *Hon. Sec.*
Thomas Cole, *Secretary.*

The Report was unanimously adopted.

The President then presented the 10*l.* premium in books to Mr. J. Paton, of Plymouth.

Mr. Escott then introduced his successor, Mr. Francis J. May, and vacated the chair in his favour.

A vote of thanks to the retiring President was proposed by Mr. Lemon, seconded by Mr. Fowler, and carried.

Mr. May read his inaugural address,* a vote of thanks for which was proposed by Mr. T. De C. Meade, seconded by Mr. Eayrs, and carried.

Mr. R. J. Thomas (Buckinghamshire), Mr. Clarson (Tamworth), and Mr. Silcock (King's Lynn) were appointed Scrutineers for the ensuing year.

Mr. Savage and Mr. Lewis were reappointed Auditors.

It having been moved and seconded, it was agreed that the various District Secretaries continue in office till the next Meeting in their respective districts.

The following papers were read and discussed :—

"River Pollution," by Professor H. Robinson. "Disposal or Utilisation of the Residue from Towns Refuse Destructors," by H. P. Boulnois. "Housing of the Working Classes—Model Cottages, Tenement Buildings, and Municipal Lodging Houses,"

* This Address, and the Papers read at the Meeting, will be found at the end of this volume.

by J. H. Brierley. "Electric Traction—a review of its application and a comparison with other methods," by R. St. George Moore. "Street Construction for Medium Traffic," by A. E. Collins. "Steam Rolling," by E. P. Hooley. "Footways," by C. H. Cooper.

Votes of thanks were accorded to the authors of the papers, to the Mayor and Corporation of Brighton for the use of the rooms of the Royal Pavilion, and to the President, Mr. F. J. C. May.

Dr. STATEMENT OF RECEIPTS AND EXPENDITURE FOR THE YEAR ENDING APRIL 30TH, 1896. Cr.

RECEIPTS.	£	s.	d.
To Balance at Bank, May 1st, 1895	235	14	4
„ Entrance Fees	53	11	0
„ Subscriptions	557	1	3
„ New Graduates	7	17	6
„ Subscriptions in advance	9	19	6
„ Arrears	18	7	6
„ Sale of 'Proceedings'	31	10	10
„ Examination Fees	104	9	6
„ Interest on Stock	13	7	4
	£1,031	18	9

EXPENDITURE.	£	s.	d.
By Reports of Meetings	18	18	0
„ Scrutineers' Expenses	3	4	6
„ Auditors' Expenses	4	14	4
„ Examiners' Fees and Expenses	27	5	11
„ Secretary's Salary, Office Rent, &c.	200	0	0
„ Printing, Stationery	65	6	5
„ Travelling Expenses (Secretary)	20	9	11
„ Premium (Design for a seal)	2	2	0
„ Illustrations	33	11	0
„ Messrs. Clowes, Vol. XXI., &c.	213	13	6
„ Bank charges	0	13	3
„ Sundries, Expenses Annual Meeting, &c.	15	11	9
„ Messrs. Sharpe, Pritchard and Co. (Solicitors)	5	5	0
„ Investment, Southampton Corporation Stock	206	17	9
„ Petty Cash	50	0	0
„ Balance in the Bank	164	5	5
	£1,031	18	9

STATEMENT OF ASSETS AND LIABILITIES.

LIABILITIES.	£	s.	d.
To Estimated Liability on Vol. XXII.	40	0	0
„ Sundry Printing, Stationery, &c.	10	0	0
„ Reporting	27	6	0
„ Balance	810	18	7
	£888	4	7

ASSETS.	£	s.	d.
By Balance at Bank	164	5	5
„ £490 Southampton Corporation 3½ per cent. Stock	529	4	0
„ Subscriptions in Arrear 96 12 0			
less 50 per cent. bad 48 6 0	48	6	0
„ 'Proceedings' in Stock 240 8 7			
less 50 per cent. 120 4 3	120	4	3
„ Office Furniture	25	0	0
„ Balance, Petty Cash in hand	1	4	11
	£888	4	7

Examined and found correct, *May 29th*, 1896. W. H. SAVAGE, T. LAWRENCE LEWIS, } *Auditors.*

LEWIS ANGELL, *Treasurer.* CHAS. JONES, *Hon. Sec.* THOMAS COLE, *Secretary.*

DISTRICT MEETING AT LONDONDERRY AND PORTRUSH.

(1) LONDONDERRY.

August 23, 1895.

Held at the Town Hall, Londonderry.

E. R. S. Escott, M. Inst. C.E., President, *in the Chair.*

The Mayor (Alderman Bell, J.P.) offered the Members a hearty welcome to the City of Derry. He mentioned several points of interest to be visited, and trusted that the Members would carry away pleasant recollections of their stay.

The President, as well as Mr. Boulnois, replied on behalf of the Association, thanking the Mayor for the welcome accorded to the Members.

Mr. R. H. Dorman was unanimously re-elected Honorary Secretary for the Irish District.

The following papers were read and discussed.

THE ELECTRIC LIGHTING OF THE CITY OF LONDONDERRY.

By JOHN CHRISTIE, City Electrical Engineer.

The question of electricity supply, both for public and private lighting, is now becoming of so much importance to municipal engineers that when the Author was asked to contribute something to this meeting of the Association, he thought he could not do better than give you a brief description of our generating station,

with details of the scheme as adopted here for the public lighting of this city.

The idea of public lighting by electricity was first discussed by the Corporation so far back as March 1888, but was allowed to drop.

The matter was again brought up two years later, and it was then agreed to take out a Provisional Order under the Electric Lighting Act of 1882.

In 1892 private companies made proposals to the Corporation, offering to lay down plant and run it under certain conditions. These proposals, however, the Corporation declined, and wisely determined to keep the monopoly of electrical supply under their own control.

As the time wore on, and the Board of Trade required the Corporation to take some active steps in the matter if they wished to retain their powers, they, in September 1892, called in Mr. H. W. Blake as consulting engineer, to advise them on a scheme.

The following year the Corporation finally decided to adopt a scheme for the public lighting of the city by means of arc lamps. This scheme, prepared by Mr. Blake, was submitted to Dr. John Hopkinson, and on his approving of the specifications, &c., tenders for the plant were invited by advertisement, accepted, and gone on with as soon as the permission had been granted by the Local Government Board to borrow the necessary estimated capital of 15,000*l.*

In the selection of a site for the station, the Corporation were particularly fortunate in obtaining on very favourable terms what had formerly been an old saw mill, situated in the Strand, at a distance of some 700 yards from the centre of the city, having a frontage of 63 feet to that thoroughfare, and extending back 230 feet to the quay, and having an opening on to the river, thus affording every facility for storing our coal direct off the steamer, and also an ample supply of water for condensing purposes.

On this site in the central portion there has been erected a substantial brick building, comprising engine room and boiler house, temporary gables being erected at each end, so that if any extensions are contemplated, the buildings can be easily enlarged to accommodate the extra plant. The chimney stack, of handsome design, is octagonal in shape, 125 feet high and 5 feet in diameter,

which is more than ample to suit any additional boilers that are ever likely to be required.

At present there are only two boilers laid down. They were supplied by Penman, of Glasgow, and are of the Lancashire type, 26 feet long and 7 feet in diameter, constructed for a working pressure of 125 lbs. per square inch. They are well provided with all the usual mountings, mostly of Hopkinson's latest type.

The feed water arrangements comprise two duplex double direct-acting pumps, each capable of supplying 900 gallons per hour against the maximum working pressure. The water is drawn from a storage tank of some 20,000 gallons capacity, placed on the roof of the boiler house, and supplied direct off the town mains. It can be delivered either direct or through the economiser, and all the steam and water pipes are in duplicate, in order to avoid as far as possible all risk of failure.

The economiser is one of Messrs. Green's, and consists of 96 4-inch tubes, 9 feet long. It is placed in the main flue, being heated by the waste gases from the furnaces. Suitable by-pass flues and dampers are provided to regulate the temperature of the feed water or shut off the economiser altogether for cleaning or repairs. To prevent the tubes from becoming covered with soot and thus reducing the efficiency of the apparatus, a small horizontal engine is provided, which, by means of suitable gearing, actuates a set of scrapers, which slowly traverse up and down the tubes, keeping their surfaces clean and free from soot. As we use nothing but Welsh steam coal we have comparatively little soot, and the scraper engine, run for an hour or two at the beginning of each run, is sufficient to maintain the temperature of the feed water well up to 200° F.

The steam is conveyed to the engine room by two lines of 9-inch wrought-iron pipe, having 6-inch branch pipes to each boiler; both lines are common to each engine, and they are all thickly coated with a non-conducting composition to prevent loss from radiation. The pipes are provided with drain pipes and steam traps.

In the engine room are placed along one side three vertical compound condensing engines of 150 indicated horse-power, made by a local firm of engineers, Messrs. Brown & Sons. The diameters of the cylinders are, high pressure 11 inches, low pressure 22 inches, and the stroke 18 inches. The average speed at which they are run is 145 revolutions per minute. Each engine has a jet condenser of its own placed under the floor of the engine room, the air pump

being operated off a crank disk on the end of the shaft. The condensing water is supplied to each engine by a separate 4-inch cast-iron pipe laid direct to the river, each pipe being fitted with a clack valve, rose head and mud box. A 9-inch cast-iron pipe serves as a common discharge to all the engines. An auxiliary injection pipe off the town mains is provided to each engine to assist at starting if the tide is very low or a suction pipe gets choked.

The speed of the engines is controlled by Hartrell's patent automatic expansion governor fitted on the crank shaft, which, by shifting the angle of advance of the high-pressure eccentric, varies the cut-off of the valve to suit the load. The distribution of steam is effected in the high-pressure cylinder by a piston valve, admitting the steam in the middle and exhausting at the outer edges, and in the low-pressure cylinder by an ordinary trick slide valve; by this arrangement the high-pressure piston gland is the only one which is subjected to the full working pressure.

All the bearings are of ample size, and are provided with a suitable means to take up the wear. The fly-wheels are 8 feet in diameter and 24 inches broad, and each weighs about 3 tons.

By means of two 10-inch leather belts, each engine drives two dynamos, placed on sliding rails one behind the other. The dynamos are of the constant current series type, made by Messrs. Siemens Bros. & Co., Limited, London. They are designed for an output of 10 amperes at 3000 volts at 750 revolutions per minute. The machines have ring armatures rotating in a double magnetic field, and are fitted with copper commutators 18 inches diameter, divided into segments, and insulated with mica. We have had them running constantly for nearly 18 months at 2500 volts, and often having them subjected to the most severe strains possible, and they have given no trouble whatever, the sparking is not excessive and the wear on the commutators very small. To keep the current constant a very ingenious regulator is provided, which automatically varies the voltage to suit the number of lamps on circuit by rocking the brushes back or forward; with these regulators in gear it is almost impossible to get more than 10 amperes for any time, and they give the current just as well on short circuit as when the whole resistance of the circuit is on. Last winter we had ample opportunity of testing them through the high winds which were so prevalent, putting lamps to work temporarily, and also when two faults would sometimes come on the cables at one time, cutting out 10 or 20 lamps.

From the dynamos the current is led to the switchboard by means of insulated cables laid in trenches under the engine-room floor.

The switchboard, also made by Messrs. Siemens & Co., is composed of slate panels, in polished wood frames. It is arranged for six dynamos and four circuits, and is provided with short-circuit field switches, double pole fuses, and a Swinbourne electrostatic voltmeter to each dynamo; each circuit having a Siemens ammeter, double pole fuses, and a Thomson-Houston lightning arrester on each end. By means of a plug-board any circuit can be run off any dynamo.

The lighting of the city is divided into two sections, each section having two circuits with lamps arranged alternately on different circuits. At present we have the lamps arranged on the four circuits as follows: 40, 43, 41 and 48, or 172 in all; but extra lamps will most probably soon be looped in to bring the numbers on each circuit up to over 50, and do away with some more of the gas lamps which still exist in some of the smaller streets.

The cables consist of $\frac{7}{16}$ copper strand heavily insulated with vulcanised india-rubber, served with a covering of bituminised jute, armoured with galvanised steel wires, the whole being covered with jute steeped in a preservative compound and laid in the ground direct. The armouring is earthed at every lamp, and also at the station ends. There are some 34 miles of this cable laid, the longest circuit being about 9 miles round, and the area lighted is, the Author thinks, one of the largest in the country. During the first six months after the plant was taken over by the Corporation we had a most unfortunate time, through failures of the lamp cut-outs, cables and other causes, incidental to the start of such a large scheme. For a long time this made the electric light most unpopular with many, but Messrs. Siemens successfully surmounted all the many difficulties as they cropped up, and in the very depth of winter entirely relaid the whole of the cables without interrupting the lighting of the city. All these failures are happily a thing of the past, and now we rarely have even a single lamp failure reported.

All the lamps are of the well-known Brockie-Pell double-carbon 32-hour type, so that in winter they only require trimming every second day, whilst in summer once a week suffices. Each lamp has fitted within itself a cut-out, which, should the

carbons burn out or the rods hang up from any cause, automatically cuts out the lamp from the circuit, and forms a by-pass for the current to go on to the next lamp.

The lamps are fixed on ornamental cast-iron pillars 25 feet high, and pitched from 75 to 250 yards apart. In the base of each pillar, inside a locked door, an isolating switch is provided, by means of which any separate lamp may be extinguished, quite independently of any of the others on the same circuit.

A brief description of our method of detecting faults on the circuits may be of interest to some of you. Daily insulation resistance tests of all the circuits are taken, and if any one shows below the normal it is carefully watched; should it become dangerously low, the position of the fault is first roughly located by means of a Kelvin electrostatic voltmeter of the ordinary type, reading up to 6000 volts; the weights on the vane are adjusted so that the scale reads 50 volts per division. One terminal of the instrument is then earthed, and the other terminal connected to the positive and negative ends of the faulty circuit, and two readings obtained, which, assuming the voltage per lamp at 50, reads directly the number of lamps from either end, about which the fault exists. By referring to the map we can at once go to almost the exact lamp, and by freeing the ends at the switch tell by means of a detector whether the fault lies in a lamp or a section of the cable between two lamps. This method the Author finds saves an immense deal of trouble, rendering it unnecessary to split up a long circuit into several parts until the faulty one is found; and if the readings are carefully taken we can always find the section within two lamps either way. If the fault proves to be in a lamp it is immediately remedied by replacing it with a spare one, and if in the cable and of low enough resistance it is at the earliest opportunity burned out dead to earth, by temporarily earthing one end of the line at the station, when by means of the loop test taken on the section with a portable testing set, the exact position of the fault is located and cut out. The Author is glad to say, however, that such faults never occur in the cable we now have through any inherent weakness of the insulation, but have always been clearly traceable to pick marks caused by some careless workman, when opening the streets, accidentally striking the cable and neglecting to report it.

The cost of the whole scheme up to the present amounts to between 18,000*l.* and 19,000*l.* The difference between this amount

and what was first estimated, is chiefly due to extensions of the scheme entered into after the contracts were settled.

The end of our financial year is not up till November, and the Author regrets that he cannot now give the exact cost of the public lighting. In winter during the long nights the works costs per lamp hour were as low as ·65*d.*, and in summer when the runs were shortest they reached as high as 1·70*d.* per lamp hour. So far as can be judged, the total costs, including everything, should not much exceed 19*l.* per lamp per annum, which, considering the number of hours we run (over 3000), is by no means excessive.

No attempt has yet been made by the Corporation to introduce private lighting, except in the Guildhall and clock, which are both lighted by lamps looped off the street mains, but as they have every facility on the site of the present station for the accommodation and working of all the necessary plant for private lighting, and as the town is particularly well situated for the working up of a most lucrative electricity supply business, the Author has no doubt that before long they will be following the example set them by nearly all other leading municipalities, and wisely keep the valuable monopoly of supplying electricity to the citizens in their own hands by extending their present station and laying down suitable machinery.

The Author has nothing further to add, except to wish all of you a pleasant time during your stay in this part of the country, and bid you welcome to inspect our generating station this evening at 9 o'clock, when you will see the machinery at work which has been described to you in detail.

LONDONDERRY CORPORATION ELECTRICITY WORKS.

HIGH TENSION.—PUBLIC LIGHTING ONLY.

Works started May 29, 1894.

Loans sanctioned.	Amount borrowed.	Rate.
£18,942	£18,942	3½ per cent.

Capital expended to October 31, 1895	£18,942
Capacity of plant	180 kw.
Number of 500-watt arc lamps	170
Number of hours of lighting for year *	2,838
Estimated number of units generated	241,302
Units used per lamp	1,419
Total of works and management costs per lamp	£12 6*s.* 0*d.*
Total expenditure per lamp, including amount set aside for sinking fund	£20 12*s.* 5*d.*

* Half the circuits are extinguished at 12 midnight, and during winter months these are re-lighted from 5.30 a.m. to daylight.

COSTS OF PRODUCTION AND DISTRIBUTION.

	Amount. £	s.	d.	Per Unit. d.
Coal, &c.	499	15	6	·50
Oil, waste and engine room stores	96	13	8	·09
Carbons	317	5	3	·31
Wages	660	15	4	·66
Repairs and maintenance	191	13	0	·19
Works costs	1766	2	9	1·75
Rents, rates and taxes	64	10	5	·06
Management and office expenses, printing, insurance, &c.	260	8	9	·26
Total works and management costs ..	2091	1	11	2·07
Interest and sinking fund for repayment of loan	1415	2	5	1·41
Total expenditure	£3506	4	4	3·48

MUNICIPAL ELECTRICITY.

By JAMES PERRY, M. Inst. C.E.

For six years, as part owner and engineer, the Author has been connected with the public and private supply of electricity in Galway, and he has thought that his views and experience in this department might have some interest to his brother municipal engineers. The counties in Great Britain have been municipalised, those of Ireland are about to be, and there appears to be a prospect of legitimate shortening of our title. Most of us as officers are entitled surveyors. It is a good old title, honoured and ennobled by the men who have preceded us, and not to be lightly discarded; as it records our origin and marks the gradual growth in the complexity of our functions. The rapid march of civilisation during the last one hundred years—the steady rise of the standard of comfort and decency, the recognition of the mutual dependence of all citizens, rich and poor, in preventing disease; appliances for street cleansing; systems of sewerage, with pumping machinery; water-works; gas-works; tramways—necessitates that the city surveyor shall be an engineer in the widest sense. As a specialist in a department he might attain greater riches and wider fame; his part is to select and control specialists as a commander-in-chief controls the complex and highly scientific departments of a modern army.

Electricity—electrical engineering if some prefer so to speak—is forced upon us, and we have got to do our duty in regard to it as we have done our duty by the other human refinements which have preceded it. Most of us are specialists in some direction as a relief and variety from the routine of official duty, and some of us are no doubt electricians as some of us are artists or musicians; but an electrical engineer is not necessarily an electrician, just as a mariner is not necessarily an astronomer. There has been for some years in the public mind a confusion between electricians and electrical engineers which would be

paralleled by supposing mariners and astronomers to be the same. Astronomers have done good work for mariners, and electricians are doing good work for engineers, but a mere electrician is not an engineer, and when he undertakes an engineering job, he necessarily makes a mess of it, and there has been a good deal of messing.

The generation of electricity is purely a question of mechanical engineering. The laying of mains involves digging and paving, the wiring of houses is a kind of plumbing, the laying of an electrical tramway is a piece of ordinary tramway engineering. The electricians have a great variety of units which they have variously named and symbolised, so that it becomes more and more difficult for plain men to understand what they write, and they tend more and more to become a select half-dozen—for the whole world—who can dispute with one another in a language which no outsider understands. Engineers who desire to keep sane should avoid trying to comprehend the discussions in which English prepositions and conjunctions are mixed up with block letters and German text letters (which in mercy to the eyes of Germans have been banished from their books), and occult phrases and names of dead persons, but it is necessary to know something of the way in which electricity is measured, and useful to know the small equation which expresses Ohm's law.

Electricity leaving a central station, passing round an external circuit and returning to the station, may be compared to an endless rope driven by a pulley in the station. If you conceive of a rope of this kind passing round capstans and through tight places of one kind and another, you will see that when it is made to circulate it will turn the capstans and heat the tight places. Note, the rope comes in as fast as it goes out and no faster, but it comes on to the pulley tight and leaves it slack. Let us call the speed of the rope ampères and the tightness of it volts; the speed is the same at every part (except for elastic movements which we may neglect), but the tightness varies. As many ampères return to the central station as leave it, but the volts vary from point to point. Now if we multiply the tightness or pull by the speed we have the power transmitted at any point. Volts multiplied by ampères measure power. It is of no great consequence how the units, ampère and volt, have been fixed, the volt means pressure or tightness of the rope; the ampère means speed or quantity per second; ampères and volts multiplied together are watts; and now we are in familiar ground because

746 watts are a horse-power. When 1000 watts run for an hour it is called a Board of Trade unit. A unit of electricity for which we in Galway charge 3*d.*, used in printing or bottle-washing, or 5*d.* used for lighting, is equal to $1\frac{1}{3}$ horse-power for one hour. This is all absolutely exact; the unit of electricity can be stated as being 2,554,155 foot-pounds. When, however, we have to compare the value of a unit of electricity for lighting purposes with that of 1000 feet of gas, we have the elements of lamps and burners coming in in ways which allow of a considerable field for discussion between gas conservatives and electric radicals. It is fair at this time of day to accept Gordon's estimate made long ago, that one thousand of gas is equal to ten units of electricity, which would make electricity at 3*d.* equal to gas at 2*s.* 6*d.*

"*Ampères*" in our analogy are units of speed.

"*Volts*" „ „ pull or pressure.

Volts × ampères are "*watts.*"

746 watts are 1 horse-power.

1000 watts for 1 hour make 1 unit of electricity.

The engineer has also to deal with the unit of resistance called an "*ohm.*"

If there were no resistance to the rope running there would be no difference in the tightness between where it comes on and where it leaves the driving pulley—that is, there would be no loss of volts; but there is resistance at every supporting pulley and at every capstan and every tight place, and at all these places the rope is less strained coming on than leaving: it is losing volts owing to resistance all along its course. This resistance might be called negative volts, but it is advisable to have a distinct unit for it, the "*ohm.*"

In any continuous current circuit the three quantities concerned expressed in these units are connected by a relation which is shown by a simple algebraic equation and is known as Ohm's law:—

$$\text{Ampères} = \frac{\text{volts}}{\text{ohms}}.$$

This relation comes into most of the electrical calculations which the engineer has to make.

If we consider the resistance between two points, and that the loss of volts between the points is due to that resistance, it will be seen that there is a further small loss from friction between the rope and the driver, and if we wish to speak of the total pull at

the maximum point in the circuit account must be taken of this friction. We speak of the difference of volts between two points on a circuit, but the *electromotive-force* of the circuit is different in the way illustrated above.

An endless rope driven as shown above illustrates machines or lamps worked in series in which the same current passes through them all, and there is a more or less great drop of voltage at each lamp or machine. A modification of the illustration shows lamps or machines worked in parallel. Conceive the different machines or lamps to be worked by separate bands or fine ropes which combine through the driver up to a certain point to act as a single rope, and at these points separate to the several machines or lamps; we must, however, modify our idea of ampères by considering not the velocity, which is supposed to be constant, but the sectional area of each separate band as representing ampères.*

Transforming.

The power of a current is measured by ampères × volts = watts; any arrangement by which for a very small loss these two factors are varied is called a transformer. Any machine by which we obtain a mechanical advantage, wheel and axle, lever, &c., is a transformer of mechanical power. With alternating currents electrical transformation is very simple; it is not so simple for continuous currents, and in this lies a great point in favour of alternating currents for certain circumstances. There are disadvantages, and we have electricians who show some partisanship both for continuous and for alternating currents. The engineer will use whichever best suits his special conditions. A continuous current transformer is a machine which revolves; the alternate current transformer has no moving parts. Accumulators, which are lead plates in cells filled with sulphuric acid, besides acting as stores for energy, are also transformers.

Continuous current dynamos are of three kinds (neglecting peculiarities of armature, &c.):—

(1) *Shunt dynamos*, in which the field magnets are excited by a shunt of fine wire connecting the poles of the machine.

(2) *Series dynamos*, in which the total current produced by the machine passes by a thick wire round the field magnets.

* If moment can be taken as ampères it will apply to both analogues.

(3) *Compound dynamos*, which have both series and shunt windings on the same machine.

Shunt dynamos are used with accumulators, because whether they revolve as dynamos or as motors they revolve in the same direction: there is always more or less chance of the dynamo and engine being driven by the accumulators. Series dynamos are used for arc lamp lighting and compound dynamos for incandescent lamp lighting without accumulators. For five years the Author has every night run arc lamps off a shunt dynamo, and he has charged accumulators with both compound and shunt dynamos. With a turbine at an inefficient speed he has also run incandescent lamps direct from a shunt dynamo without any injury, so that the above rules in some respects are flexible.

The electrical arrangements at a central station are extremely simple. The part in which there is any complication is the accumulator portion. Accumulators if used for storing are in first cost very expensive as compared with gas-holders, and if used as regulators they involve some little complexity in connections and switches. In London, accumulators should not give very much trouble where the companies who manufacture them agree to maintain them at a percentage of their first cost per annum; but in out-of-the-way places like the West of Ireland, they will give trouble till they are set free from the last restraints of the Patent Office. With proper arrangements on the premises for remaking defective plates, the maintenance of accumulators will give very little trouble. Accumulators are specially suitable for water power because they allow of the power being utilised during the whole 24 hours. There is a loss of energy in accumulators of about 25 per cent.

Mains :—The Three Wire System.

The filament of a glow lamp is of such a thickness (or sectional area) that a given number of ampères being forced through it heats it to the required brightness (the brightness determining the life of the lamp). In two lamps A and B, suppose A to have a filament twice the length, and half the sectional area of B. A will only require half the ampères, but it will need twice the volts (or pressure) to give the same candle-power as B at the same brightness. If there were no practical limit to the fineness of filaments we could save largely in the copper of the mains by

keeping the voltage up to the limit fixed by the Board of Trade as low pressure; but it appears to be desirable to have lamps of 8 candle-power, and the conditions of filament appear to limit the voltage to about 110; with cheaper electricity enabling us to use a minimum lamp of 16 candles, we could double the voltage and very much increase the capacity of our mains.

By Ohm's law, volts = ampères × ohms, but the rate of work = ampères × volts;

$$\therefore \text{ rate of work} = \text{ampères}^2 \times \text{ohms (in watts)}.$$

Every current in a conductor does work by heating the conductor; this is waste, and the rate of waste is proportional to the ampères^2, so that it is seen how important it is to keep the ampères low by keeping the volts high. It is of the greatest importance to keep the mains at a nearly equal voltage, and our copper must be proportioned to the drop we calculate for in designing the mains. Now suppose we calculate for a drop of two volts from one end to another of a series of lamps, and suppose the ampères to be 50, and the voltage of the lamps to be 110. If we replace the ordinary lamps by others having filaments twice as long, the cross section remaining the same, the voltage must be increased to 220, but the lamps will give twice the light and there will be no more than the 2 volts drop, because the ampères will not have been increased; but if we had arranged to get twice the light at the 110 voltage with the same loss we should have had to multiply the quantity of copper by 4, so that we save $\frac{3}{4}$ of the copper by doubling the voltage. We need not have our double filaments in one bulb, but we may place two common lamps in series between the conductors, they need not be close together, they may be in different apartments, but they must be turned on or off together. We shall get rid of this inconvenience if we run a small main connecting the middle wires of the lamps, because if the lamps are unequal on the two sides of the middle the balance of current flows up or down the wire. This is the three-wire system. The three wires need not be carried into the houses, but consumers should be balanced on the mains in the streets.

It would appear that the network of a low-pressure system should be fed from centres about $\frac{3}{4}$ mile apart. The network should consist of two conductors laid down each footpath, one of them being cross-connected to form the middle wire of a three-wire system. The size of the conductors of the network should

be (probably) uniform, extra business in certain localities being provided for by extra feeders. The network should be fed by mains from which no services of any kind must be taken. These feeders will vary so that whatever the length may be they will all have the same *resistance*, so that the drop in volts in each feeder shall be the same. The secondary centres may all be supplied from a principal centre, accumulator transformers being used in the secondary or feeding centres. There are continuous current motor transformers, of which we do not hear much in actual practice, but it would appear to be quite feasible to send a high-pressure current from compound dynamos arranged to give a fixed voltage at the centres, and transform it down to the low-pressure centre voltage. Two years ago we met suggestions for small step-up transformers placed in mains so as to allow of the voltage to drop two volts below normal, and at such a point transform it up four volts; but we have heard little of this device in practice. In Galway we shall probably complete our half mile radius of low-pressure area, and deal with the outlying straggling places with alternating currents.

The enemy to be met everywhere in a continuous current system is electrolysis. If you maintain two pieces of copper wire at different voltages, and dip them in a solution of sulphate of copper, that which is of the higher voltage will waste away and the wire of lower voltage will become thicker. If two naked copper conductors rest on porcelain or glass insulators in an underground culvert it is almost impossible to prevent damp from making a connection with the earth. Pure water is almost an absolute non-conductor, but the word *almost* condemns it, because the faintest trace of hydrated oxide of copper improves its conducting power; probably its first encouragement comes from common salt, which is a universal enemy. The rate at which the "earth" becomes good is a rapidly increasing one; it results in one main being eaten through at the insulator and the other main forming an incrustation of metallic sodium at its insulator, and this incrustation may drop off, and meeting with actual wet strike a light which fires gas which may have accumulated in the culvert from gas mains. These culverts are exceedingly expensive things to construct; there is difficulty in keeping them drained and ventilated. Water accumulates in them; they are regular traps for water owing to the steady temperature of the ground and the varying temperature of the air. Service connections are

troublesome. Various makes of continuously insulated lead-covered mains are in the market, the difficulty with them is in service connections. Where such mains are armoured the light character of the armouring does not promise long life in damp soils. The threading of cast-iron protecting pipes on a long length of main is difficult unless the pipes are roomy. The Author has had experience with different kinds of mains. The variety of practice in this respect indicates an uncertainty which experience will by-and-by settle, we shall in the end have only one or two kinds. The Author has devised a main of his own, but as it is yet untried he had better say little about it. Leaky electric mains besides wasting themselves away may do some injury to gas and water pipes buried in the ground close to them. Wherever the iron pipe is at a higher voltage than the earth in contact with it, there rusting of the iron is promoted. Tramways with rail returns may do much damage in this way. For electric lighting by gas engines, accumulators are a necessity; any kind of throb or irregular revolution shows very distinctly in incandescent lamps. For some time the Author ran incandescent lights off a compound dynamo driven by a wooden water-wheel; if the wheel stood idle for a short time so that the upper part got dryer, and consequently lighter, than the lower portion of the rim, the rise and fall of the heavy part of the wheel could be seen in the lights till the wheel got equally soaked with wet all round. If alternators could be satisfactorily run with gas engines the question of storage of electricity would be solved, because gas may be comparatively cheaply stored, and a series of gas engines might be put into work as the load increased and put out as the load diminished; the only inconvenience in such an arrangement being that it would be necessary to have a generating plant with reserves equal to the maximum demand. Another way of meeting the varying load is to keep the engines going all the time at a steady electrolytical manufacture of some kind which might be considered a bye-product of electric lighting.

With the method of differential charging to consumers the Author has but little sympathy, it is a throttling kind of action. Electric men have sooner or later to face the gas men in deadly combat as suppliers of light, and they have got to do it by reducing prices and standing on a common platform of equal rates. A differential charge for power supply is legitimate, it comes into the competition with the gas men.

In the few remarks made by the Author in seconding a vote of thanks to the Borough Surveyor of Belfast, he suggested a 3*d.* rate per unit. Other people have come to this 3*d.* unit, and the Author is now inclined to halve it as a reasonable rate in large towns. When electricity is to be had at 1½*d.* a unit, a 16 candle-power lamp will keep lighting for 13 hours for 1*d.*

With alternating currents the Author has hitherto had no practical experience, but he is contemplating using them in the near future. The beautifully steady power of turbines, with which we work in Galway, appears to suit alternator work, but the obvious applicability of accumulators as a means of making the most of a water-power decided our commencing with continuous current. When increase of business drives us to auxiliary power, we shall no doubt run alternators at night with our turbines and put them to continuous-current work in the daytime.

A new form of tramway is just now being experimented with, worked with alternating currents, and it may possibly set at rest for ever the vexed questions between overhead trollies and underground trollies; no form of trolly, good or bad, being needed for the new kind of tramway.

The public and private lighting should be all done from the same mains.

In Belfast the area selected for an experiment is an early closing shop area, and it is in this respect not the best. The scheme would be improved by adding public to private lighting. The best kind of work is public lighting, which continues during all the hours of darkness; the worst kind is that of early closing shops, which in summer take no light at all, and in winter they all light up together for a short time. The Belfast experiment appears to be further handicapped with dear fuel; town gas burned in gas engines and costing 2*s.* 3*d.* a thousand is a lavishly expensive fuel. Belfast is a plucky egotistical place, and the mass of the people will not long be grovelling in worship of a row of smoky chimneys in Cromac Street.

The subject is probably too large to be satisfactorily treated in a paper of this kind. The purpose of the paper, however, is not to be a treatise on the engineering applications of electricity, but to reassure municipal engineers who are kept hard at work in an already complicated routine that this new claimant of attention is in no way dangerous; that he is amenable to familiar and kindly treatment. The Author, while engaged in a varied practice, has

formed a strong attachment to this new professional friend, and he is desirous that he shall receive kind treatment from his brother surveyors when he knocks, as he soon will do, loudly at their doors.

Note.—This paper has been considerably criticised. It has been variously misunderstood, and there consequently may be some obscureness of expression which the Author fails to see.

An editor critic finds fault generally that it is too elementary, and he is mystified by the expression "negative volts" used for "back electromotive force," but this is an ordinary mathematical use of the word "negative," which the Author expected everyone to understand. Another editor supposes that the Author intends to rectify alternating currents to continuous currents, and awaits the result of the experiment.—J. P.

DISCUSSION.

Mr. T. De Courcy Meade: I have pleasure in proposing a vote of thanks to the Authors of the papers. In the first paper, that of Mr. Christie, we find that in Londonderry the installation is restricted to street lighting only, a reversal of the procedure in many other towns where public lighting by electricity has not up to the present been attempted. In Manchester there is a larger demand for the light for private consumption than can at present be met, and therefore the Corporation is now engaged in enlarging the works and extending the area of supply. The Corporation of Londonderry having adopted public lighting alone, can show no profit, nor can there be any hope of making a reduction in the cost of street lighting as compared with gas for many years to come. I observe that Mr. Christie says nothing about the price of gas. I shall be glad if he would give the cost per lamp for gas and for electricity. If we could obtain from electrical engineers reliable information as to the relative cost of the two lights (without giving undue credit to electricity for illuminating power) the public would, I believe, have less hesitation in using the new and very much superior illuminant. The second paper, by Mr. Perry, will no doubt induce some municipal engineers to approach the subject of electric lighting and make themselves conversant with this new branch of science. But the municipal engineer who has not received a special training, both theoretical and practical, will be a very bold man indeed if he attempts the responsibility of laying down a large installation without the advice and assistance of an experienced and thoroughly reliable electrician. None but trained electricians devoting their whole time to the work can keep pace with the rapid advancements and improvements that are being made in the application of electricity to municipal purposes. Personally I am very much obliged to Mr. Perry for his interesting and instructive paper, although I cannot endorse all his views. I think, however, that it would be a calamity if any of our Members who have not had a very special training were induced to undertake or advise upon works of this kind. Some of us can remember the

failures which occurred in the early days of sewerage and sewage disposal work from the same cause, but I am glad to say that this state of things has long since past. The examinations held by the Association, and the visits to works, have done much to improve the status of the municipal engineer and to qualify him for the difficult works he has to perform.

Mr. E. Pritchard: I have great pleasure in seconding the vote of thanks to the authors of the papers. I agree generally with the remarks of Mr. Meade, and on one point I should like to know something further of the reason for generating electricity at great expense for the purpose of public lighting only. Public lighting by electricity has been attempted in many cities, and in some of those cities it has been abandoned. Take London. We had first introduced the system of arc lighting, which was abandoned. Then we had the incandescent lighting on Holborn Viaduct, which also came to grief. Latterly we have had the system of arc lighting again introduced, but it has been confined either to open spaces or to wide streets. I have seen the electric light in America and on the Continent, and there it has been very successful because the streets are wide. I should like Mr. Christie to say why, in Londonderry, electricity has been confined to the public lighting of the city; whether it is due to the streets being better adapted for the light than those of other towns. In Birmingham there is an important electric lighting company, and there is also one in Liverpool, but neither in Birmingham nor in Liverpool has there been any attempt made to introduce the electric light for street lighting. In Birmingham the company only desired to be permitted to supply the light to business premises and to offices, thus confining itself to the domestic supply. This pays the company very well, and though individual offices do not consume very much electricity, the number of customers is being rapidly extended, and in a short time the interior of the whole of the buildings in the centre of Birmingham will be lighted with electricity. The price of gas in Birmingham is very cheap, being 2*s.* 7*d.* per 1000 cubic feet. It may be on that account that electricity is not able to compete with gas for street lighting, or, on the other hand, it may be because the gas-works belong to the Corporation and have been a source of great revenue, that it would be unwise to interfere with gas lighting in the streets. We have very few cities lighted with electricity where the light is not supplied for domestic purposes.

With regard to Mr. Perry's paper, I think as municipal engineers we should feel grateful to him, because we have not all the time at our disposal to master these difficult subjects. Mr. Perry has assisted and directed us to an easy way of understanding the subject, and municipal engineers can point to the paper as a very instructive and useful one. All municipal engineers will never become all-round electricians, but they are a necessary adjunct, and will work in conjunction with electricians. The question of accumulators has been dealt with, but only in connection with electric lighting. We are told by all experts that the day of accumulators has to come; and that the present failure of accumulators will be thoroughly overcome. My own experience is that in tramway traction accumulators have proved a great failure. With the constant strain of tramway work they are practically useless after two or three months' work. The accumulator mode of traction is very nice, but it is not one which will give a return to the shareholders in its present form. It would be very interesting if Mr. Perry could give us some information as to the new form of electrical traction which I believe his brother is experimenting with. I understand that the invention is registered. Of course I must not assume that Mr. Perry is free to say everything respecting this new system, but I am sure a few words of explanation would be of very great interest to tramway engineers and others. I would like again to refer to the great ability with which the papers have been prepared, the first by Mr. Christie and the other by Mr. Perry: but I think particularly Mr. Perry is to be thanked for the interesting and instructive paper which he has given us.

Mr. J. Lobley: I have pleasure in supporting the vote of thanks to Mr. Christie and Mr. Perry for the papers we have had this morning. With regard to the system of electric lighting adopted in Londonderry, it may be said that the city was the pioneer of public electric lighting as distinct from private lighting in this country. It is a very serious matter for a town to establish electricity works for public lighting alone. The first cost of the works, together with the annual expenses, presses heavily on the rates when the whole has to be charged to the public street lighting account. I desire to know a little more as to the cost per unit, and also the number of hours the lamps are lighted. I think that where private lighting is undertaken, the public streets should also be

lighted by electricity. I cannot, however, agree with Mr. Perry that the public and private lighting should be done from the same mains. One great advantage of lighting the streets by electricity, is the ease with which the light can be switched on and off. With electricity there is no need to turn on the light until later than gas, because the whole area can be lighted up at once, whereas with gas a considerable time is occupied with the lighting of the lamps. That advantage can only be obtained by having separate mains. Then, again, where the lamps are arranged in series, a higher voltage is required than for the private supply mains. Another reason for undertaking the public lighting, is that it is a very good advertisement for the private lighting. In places where the public streets are lighted by electricity they have the largest number of private consumers of the light. I advocate incandescent electric lighting for indoors, and arc lighting for out of doors; but there are small narrow streets in most towns where incandescent lamps might be used with advantage. I believe the borough engineer is the right man to pull the streets about, and he ought to take sufficient interest in the work to advise his council on such matters. The civil engineer may very fairly go hand in hand with the electrician, and will doubtless require his advice and assistance, but that is a very different thing to surrendering what I contend are civil engineer's works to another department outside his control. The advantages of the alternating current make it very useful for straggling places. I have not a customer further than two hundred yards from what is practically a generator station, that is a transformer sub-station. Therefore it is not necessary to go into the complexity of the three-wire system. It may be that Birmingham, Manchester and Bradford have done wisely in adopting the continuous-current system, and some places in London have done unwisely in adopting the transformer system. In my own town the transformer system is very valuable indeed. Our first capital outlay was 22,000*l*., and we are now engaged in doubling our works. The first six months' revenue from the supply of electricity paid the whole of the working expenses, the interest on capital, and sinking fund charges. I scarcely think the present six months will do so well, as we are running the works continuously during daylight with little consumption. At present we have got more customers than we can supply. We have our own Corporation buildings

wired, but dare not put them all on. I hope we shall have a 500 horse-power steam alternator, by Ferranti, at work in a few months, which will get us out of this difficulty. With regard to cost, the 8-ampère arc lamps are charged 480*l.* per annum for 30 lamps. The incandescent lighting of our free library at 6*d.* per unit costs 15 per cent. more than gas at 2*s.* 9*d.* per thousand feet, but we have much more than that extra amount of light, and there will also be a great saving in bookbinding, cleaning, &c. I previously had over my own desk two 15 candle-power gas burners of a good make, and I find that one 16 candle-power incandescent electric lamp will give me the same light.

Mr. G. J. C. Broom: I quite agree with Mr. Meade when he says that the borough engineer would be indeed a very courageous man who undertook the lighting of a town by electricity. In a busy town there is no time for the borough surveyor to get up the question of electricity. In St. Helens, two years ago, I put in 400 lamps with the necessary engine and dynamos for the Town Hall. That was a special arrangement, inasmuch as the Town Hall was under the control of the Public Works Committee. We have now called in an electrician, who will, under the charge of the Gas Committee, carry out the lighting of the town. That is the proper thing to do. I do not think any engineer, who has so many and various duties to perform, can give sufficient time to carry out the lighting of a town in a proper and efficient manner. There is one remark in the paper of Mr. Christie to which I should like to refer, that is with regard to mains being damaged by pick marks. I should like to ask whether the mains are cased in any way, or merely laid in the ground without any casing at all.

The vote of thanks to the Authors of the papers having been unanimously accorded,

Mr. J. Christie, in replying to the discussion, said: The first question was the comparative cost of gas and electricity for lighting the streets. Formerly we had about 700 gas lamps, and 550 of these were replaced with 170 arc lamps. The cost of gas lighting was about 2200*l.* a year, and I estimate that the cost of the electric light, including the repayment of loans and everything, will be 3500*l.*, and the additional cost for the existing gas lamps 500*l.*, making a total cost of 4000*l.* as against 2200*l.* But you must consider that those streets which have the electric light are about twenty times better lighted than when lighted by gas. The

price of gas was formerly 3*s.* 10*d.*, but has now been reduced to 3*s.* 7*d.* per 1000 cubic feet, a reduction which I take to be due to the introduction of the electric light. I am of opinion that the public and private lighting should be run in conjunction, and that it would have been better to have at first worked up a private lighting supply along with a few public arcs in the centre of the town, extending both systems as the demand increased. In reply to Mr. Broom's question, I may state that our cables are laid in the ground direct, and have armour composed of steel wire for mechanical protection.

Mr. Perry, in replying to the discussion on his paper, said: I think I must have failed to make myself clear to Mr. Meade and to Mr. Broom. I do not propose that the borough engineer should be the electrical engineer, but I maintain that there ought to be an engineering chief, and that that position ought to be filled by the borough engineer. If an electrical engineer is called in, the borough engineer ought to know what he is about. I do not think there is time for me to do more than to say something about this new form of electrical traction which has been invented by my brother. We, all of us, whether enthusiastic electricians or practical men, like to see a thing tested before saying too much about it in public, but I do not think there is any harm in my explaining the principal points in the system. You are all aware that in the existing electrical systems you must have direct contact, but for a magnet circuit contact is not necessary. All the electric trams which have been worked up to the present have been worked on a circuit, which involves contact. The new tramway is simply an extended alternating transformer, which will be spread out all along the track. A number of thin plates of iron will be laid upon the track, enclosing a thin band of copper through which the alternating current will be sent, magnetising the sheets of iron, and thus actuating the motor without any direct contact. Of course it will be run quite close, but there will not be actual contact as is involved with the present systems. The success of the system is dependent entirely upon the first cost of a line of this character not being excessive.

The Members attending the meeting were entertained to luncheon by the Mayor in the Council Chamber of the Guildhall. The Members then walked along the city walls and visited the

Cathedral, the Walker Memorial and other objects of interest, under the able guidance of Mr. Robinson and Mr. J. G. Ferguson. After the completion of the tour of Derry, the Members were taken by train to Buncrana, a charmingly situated village on Lough Swilly, where dinner was served at Lough Swilly Hotel.

The Members then returned to Derry, where a visit was paid to the City Electrical Station, and the installation for public lighting inspected, under the guidance of Mr. J. Christie, the Electrical Engineer.

DISTRICT MEETING AT LONDONDERRY AND PORTRUSH.

(2) PORTRUSH.

August 24, 1895.

Held at the Town Hall, Portrush.

E. R. S. Escott, M. Inst. C.E., President, *in the Chair.*

The following papers were read and discussed.

LIGHT RAILWAYS AND TRAMWAYS.

By R. H. DORMAN, M. Inst. C.E., County Surveyor, Armagh.

So much has been written regarding light railways and tramways during the past few years, that it is difficult to prepare a paper containing any new matter on these subjects.

It is probable, however, that nearly all the Members of this Association are called on occasionally to report in some way or another respecting their construction, and it is therefore to be hoped that the few remarks which the Author proposes offering may give rise to an interesting discussion.

The Author has thought it advisable to confine his remarks chiefly to light railways and tramways as constructed in this country. Although he was engaged for some time on railway work in England, and superintended the construction of the Highgate Hill Cable Tramway for the Hornsey Local Board, he is better acquainted, and has been connected for the greater part of his life, with work of this kind in Ireland.

It is not proposed to deal with the lighter descriptions of tramways, namely, such as might be laid down in order to connect a series of farms with a neighbouring town. Such tramways are not required at present, and probably never will be required in this country.

A light railway in Ireland is defined by the 31 & 32 Vict. c. 119, as a railway on which the weight on one pair of wheels of the engine does not exceed 8 tons, and the speed adopted does not exceed 25 miles per hour.

The chief difference between a light railway and a tramway appears to be that a light railway is run over land which is specially acquired for the purpose, while a tramway runs over or alongside a public road, and the speed is limited to 12 miles an hour in the country and to 6 miles in towns and villages.

Light railways and tramways in this country may be classed as follows:—

(1) Light railways both of the ordinary 5 feet 3 inches gauge and narrow gauge.

The line known as the Bessbrook and Newry Electric Tramway should be properly classed as a light railway, as it runs over specially acquired land all the way, except where it crosses the public roads.

(2) A composite type. Those which run for part of their course over specially acquired land, and for part of their course along the public road.

(3) The Lartigue system.

(4) Tramways of various gauges and worked by steam, by electric power, by a combination of steam and electricity, and by horses.

The light railways and tramways in Ireland have been constructed—

(1) As feeders to existing main lines.

(2) To open up tracks of country through which no railways run, and in which there is no probability of heavy trunk lines ever being constructed.

(3) Horse tramways in the larger towns.

(4) Short lines for the accommodation of special industries.

The capital for the construction of the 4th class has usually been obtained from private sources, and for the 3rd class it has been obtained in the open market. Previous to the Act of 1883 the capital for the 1st and 2nd class was obtained by the barony, or

baronies, through which the line passed, giving a guarantee for a portion of the capital, generally for a limited number of years, afterwards ratified by a special Act of Parliament, which also authorised a loan from the Board of Works and the issue of ordinary shares. In 1883 a special Act of Parliament was passed by which the Treasury guaranteed to the county a maximum of 2 per cent. when the grand jury gave a guarantee of 4 per cent. or more ; this Act also conferred powers for the compulsory purchase of land, and did away with the necessity of obtaining a special Act for each particular line. A considerable stimulus to the construction of light railways and tramways was given by this Act, but it is to be regretted that the 2 per cent. guarantee given by the Treasury was not made a direct guarantee. If a direct guarantee of 3 per cent. were given by the Treasury, a portion of which would of course be raised by the county, it would be as easy or easier to find the necessary capital for the construction of a line than it is now with a guarantee of 4 or 5 per cent. from a grand jury.

As a general rule the light railways of the ordinary gauge are worked, and the rolling stock or part of it provided, by the railway company to which the light railway forms a branch, or of which it is an extension, for a percentage, usually 50 to 55 per cent., of the gross receipts. A working agreement of this kind is always favoured, and sometimes insisted on, by the Treasury as some security that a line will be kept open. Instances of railways having been opened for traffic and afterwards abandoned have occurred; as, for example, the Parsonstown and Portumna Railway, the rails, sleepers, and even the station building of this railway having been appropriated and removed by the country people.

It may be mentioned here that the majority of these railways have at first proved anything but remunerative, and in some cases the receipts have proved insufficient to meet the working expenses; but almost invariably the receipts are found to increase annually, and in some cases these railways are now able to pay not only the baronial charges, but also a dividend on the ordinary shares, or a contribution to the baronies, as specified in Sect. 5, c. 43, 46 & 47 Vict.

This result proves that increased traffic is created by the construction of these railways in the districts through which they run, and the ultimate benefit to these districts can hardly be overestimated.

Gauge of Light Railways and Tramways.

The great majority of engineers in this country favour the adoption of the Irish 5 feet 3 inches gauge, and with good reason. Railways in this country can generally be constructed easily and cheaply; they are to a great extent surface lines, and as a rule no expensive works are required in connection with them.

By the adoption of the narrow gauge there would doubtless be a slight saving in the cost of land, in masonry works, in earthworks, and in ballast, but there would be no saving in the promotion of the scheme in the first instance, nor in station buildings, nor in fencing, nor in signalling, &c., and not much saving in maintenance and working expenses, while the advantages of being able to interchange rolling stock with other lines far outweigh the slight saving in cost effected by adopting the narrow gauge. Moreover, the rolling stock adopted for narrow gauge railways is not suitable for the conveyance of cattle, one of the most important items of traffic over Irish lines.

In the case of tramways the gauge which should be adopted is more difficult to decide. For tramways running along the side of a public road, in which case the rails need not be kept on a level with the surface of the road, a 3-feet gauge will probably be found the most suitable, a greater width of roadway (which must not be less than 18 feet) can thus be left than if a wider gauge were adopted, and sharp bends in the road can be manipulated more easily. In the case of tramways running over a central track, the 4 feet 8½ inches or 5 feet 3 inches gauge is usually considered the most convenient.

Curves and Gradients.

For light railways of the ordinary gauge the sharpest curve usually adopted is ten chains, but the Author has occasionally known curves as sharp as seven chains put in. For light railways of the 3-feet gauge, curves as sharp as two and a half chains are sometimes tried, and on tramways of the same gauge curves of one chain radius can be worked round. At each terminus of the Bessbrook and Newry tramway (3-feet gauge) there is a loop of 55 feet radius, round which the cars are easily worked in order to avoid the necessity of reversing them; it should be remembered, however, that these cars are of the bogie type. Gradients steeper than 1 in

30 are seldom adopted in this country on railways and tramways worked by mechanical means, and considering that owing to an unfortunate clause in the Act 31 & 32 Vict., the weight on one pair of wheels of any engine shall not exceed 8 tons, it is evident that only light trains can be taken over a gradient of 1 in 30. If anything in the shape of heavy traffic is anticipated, the gradients should not, if possible, exceed 1 in 60.

Cost of Construction.

The cost of constructing and equipping a light railway or tramway has been variously estimated at from 1000*l.* to 10,000*l.* per mile, and a few tramways have been constructed in England at a cost of about 1000*l.* a mile, but I think the lowest at which any tramway has been constructed and opened for passenger traffic in this country is 1800*l.* per mile, the approximate sum at which the Warrenpoint and Rostrevor Tramway, 3 miles 20 chains in length, was constructed. Probably no light railway has been constructed and equipped in this country at less than 3000*l.* per mile; perhaps the cheapest line which has come under my notice is a branch of the Cavan, Leitrim and Roscommon Light Railway and Tramway, from Ballinamore to Drumshambo, which is stated to have cost only 3100*l.* per mile. The gauge of this line is 3 feet; weight of rail 45 lbs.; weight of engines 20 tons when empty; steepest gradient 1 in 30; and sharpest curve 250 feet radius. The engines are specified as being capable of taking a train of 100 tons up a continuous incline of 1 in 40, for one-third of a mile, with curves of 10 chains radius.

A few other examples may be given showing the comparative cost, &c. of light railways and tramways in Ireland. The Castlederg and Victoria Bridge Tramway (7 miles 12 chains): 3-feet gauge; cost slightly over 3000*l.* per mile.

The Portstewart Tramway (1 mile 68 chains): 3-feet gauge; cost also slightly over 3000*l.* per mile.

Schull and Skibbereen Railway (14 miles): gauge 3 feet; weight of rail 45 lbs.; steepest gradient 1 in 30 for a distance of 1 mile; sharpest curve 2½ chains; cost 4000*l.* per mile. When this line was first opened for traffic, four engines were provided, one only being of the bogie type, the remainder Stiff, which, however, proved very unsatisfactory.

Clogher Valley Light Railway and Tramway (37 miles 3 chains): gauge 3 feet; weight of rail 45 lbs.; steepest gradient 1 in 30; sharpest curve (in the town of Caledon) 1½ chains; on private land, sharpest curve 4 chains; cost about 4000*l.* per mile.

Clonakilty Extension Railway (8 miles): gauge 5 feet 3 inches; weight of rail 65 lbs.; steepest gradient 1 in 70; sharpest curve 15 chains; cost about 4500*l.* per mile. Although this line cost such a small sum to construct, it can hardly be classed under the head of a light railway, and it was not constructed under the Act of 1883, but under a special Act.

The Author would mention that all the above lines are worked by locomotives except the Darrenpoint and Rostrevor Tramway, which is worked by horses, and also that the estimates given include the cost of rolling stock, except in the case of the Clonakilty Extension Railway, which is worked by the Cork and Bandon Railway for a percentage of the gross receipts.

Method of Construction.

The method of construction is usually pretty much the same for light railways and tramways of the kinds mentioned above.

The rails are of the Vignoles section, weighing from 45 to 65 lbs. to the yard. The sleepers for narrow gauge lines 6 feet by 8 inches by 4 inches, for ordinary gauge 9 feet by 9 inches by 4½ inches: both creosoted and uncreosoted are used, generally rectangular, but sometimes half round. The sleepers are generally placed 3 feet apart centre to centre, and at the joints 2 feet centre to centre. As the traffic on these lines is not very heavy, the rails will last for a very long period without requiring to be renewed, but the life of the sleepers deserves consideration. Ten years is found a good average life for Baltic sleepers creosoted under pressure, but they will frequently be found sound after being in as long as 15 years. Six years would be a fair average for the same sleepers merely dipped, and 5 years if unprotected. Scotch fir sleepers will last about 5 years, and larch about 8 years, but larch is not always obtainable. While on the subject of sleepers, the Author might mention that he had recently to inspect a short narrow-gauge line on which very light wrought-iron sleepers were used; they seemed very well adapted for their purpose.

The rails are secured to the sleepers by dog-spikes; frequently

fang bolts in addition are used at the ends of each rail, and on curves sometimes about the centre of each rail as well. Sole plates are also occasionally used.

Depth of ballast about 12 inches below the under side of the sleepers, bottom ballast 6 inches quarry shivers, top 6 inches gravel or broken stone; gravel is probably the most suitable ballast for light railways, as broken stone makes a harsh and noisy road.

Details of Cost of Construction.

The most important item is usually for permanent way, and this, including fencing, is variously put down for a light railway at from 1000*l.* to 1800*l.* per mile. The rails, fish plates, bolts, &c., of course vary with the market, but as regards the other items of permanent way, uncreosoted sleepers 9 feet by 9 inches by 4½ inches, cost about 1*s.* 6*d.* each; laying permanent way 1*s.* 6*d.* per lineal yard forward; ballast-pitching and boxing also 1*s.* 6*d.* per yard forward; sod fencing both sides 9*d.* to 2*s.*, per lineal yard; and wire fencing 1*s.* per lineal yard.

Clay cutting is probably the next most important item, and is frequently put down at 1*s.* a cubic yard for cutting, and 8*d.* for filling; sometimes cutting and filling are estimated together at 1*s.* 2*d.* to 1*s.* 8*d.* per cubic yard, and 1*s.* 2*d.* a yard will generally be found a very fair price for it.

Rock is estimated at 1*s.* 6*d.* to 4*s.* a cubic yard, according to circumstances.

Masonry work varies so much that it would be impossible to put an average price on it.

Metalling and forming roads and level crossings, 1*s.* to 2*s.* per yard super.

The above give some idea of the prices at which work is let to a contractor. The actual cost is of course in many cases far less. The Author has known clay, for instance, taken out and tipped at 4*d.* per cubic yard, and fencing sublet to a labourer at 1*s.* 6*d.* per Irish perch.

Rolling Stock.—Engines, 500*l.* to 1800*l.* each.
Coaches, 300*l.* to 500*l.* „
Waggons, 50*l.* to 150*l.* „

Objections, etc. to Tramways Running along the Sides of Public Roads.

When the condensation of the escape steam is properly effected, the machinery invisible and the sound from it inaudible, the danger of running a steam engine along a public road is very much minimised; while further, if ample room is left for the ordinary traffic, little objection can be raised to the construction of a tramway alongside it. A few minor objections, however, may be raised —for example, the duty of seeing that the line is constructed in a proper manner, and that it is fit to be opened for traffic, lies with the Board of Trade, but the onus of seeing that public rights are not interfered with, and that the roadway is maintained safe for traffic is left to the county surveyor. As, however, the contractor can frequently save a few pounds by taking in a little more of the roadway on one side instead of a strip of land on the other, and the engineer can obtain better gradients by dropping his line a little below the roadway in places, the county surveyor has to exercise constant supervision over the work. Once the contractor has got his line laid down it is very difficult to induce him or compel him to alter it. Another objection to these tramways is that they are frequently raised to suit the gradients, 2 or 3 feet over the road level, and the occupiers of the fields inside the tramway are constantly endeavouring to cart across the line, and in order to do so have to make some sort of an approach on the public road to reach the tramway level, and so raise a dangerous obstruction to the road traffic.

Electrical Tramways.

Electrical tramways may be classified under five heads, according as—

(1) The conductor is an overhead wire;
(2) Is laid underground;
(3) Is a central rail laid on the surface;
(4) Is a side rail; or
(5) When accumulators are used.

The overhead system, which may be subdivided into the span wire system and the side wire system, is doubtless the best known in Great Britain. Some of the objections raised to it are the un-

sightly appearance of the poles, the difficulties at sharp curves and where wires cross, and the possibility of the wires breaking. I understand, however, that the poles recently erected in connection with some continental systems are "things of beauty," and one objection to this system has therefore been got over; moreover the difficulties with sharp curves and cross wires have been very much minimised, while the danger of the wire breaking is little more than imaginary. This system will probably be found, as a rule, the most suitable for suburban and rural lines.

The underground system will no doubt come more into favour for street tramways, but it is an expensive system: a slot of any sort in a street is objectionable, and the difficulty of keeping the tube free from dirt is an objection to it.

For light railways or tramways laid on private land, or carried overhead or underground, the central rail is perhaps the simplest and cheapest, but the difficulties of arranging points and crossings owing to the central rail, are considerable.

In particular cases, as in the case of the Portrush and Causeway Tramway, the side rail answers well.

The cost of the accumulator system renders it generally prohibitive.

Two of the earliest electrical tramways constructed in the United Kingdom were the Portrush and Causeway Tramway, opened in 1883, and the Bessbrook and Newry Tramway, opened in 1885. Both of these tramways have been fully dealt with in papers read before the Institution of Civil Engineers, and it is therefore unnecessary for the Author to enter into many details regarding them.

In both cases the electricity is generated by means of turbines worked by water power. The generating station in connection with the Portrush and Causeway Tramway is some 7 miles from Portrush, the starting point of the tramway, while the generating station in connection with the Bessbrook and Newry Tramway is at Millvale, about half-way between Bessbrook and Newry. At both places the arrangements are so simple that only one attendant is required at each station to look after the whole of the machinery, &c.

Portrush and Causeway Tramway. This line is 8 miles in length and 3 feet gauge; the conductor is at the side and of T-iron, weighing 19 lbs. to the yard, placed about 2 feet 6 inches above the level of the permanent way. Contact is maintained by

means of brushes projecting from the side of the cars, and the return circuit is conveyed through the tram rails. The cars are taken from the terminus of the Northern Counties Railway to the commencement of the electric tramway, a short distance out of Portrush, by means of ordinary locomotives.

Bessbrook and Newry Tramway. This line runs from Newry to Bessbrook in County Armagh, a distance of 3 miles 2 chains. The gauge is 3 feet, and the maximum gradient 1 in 50. The conductor consists of a central rail of channel section resting on insulators; at the joints the electrical connection is made by means of bent strips of copper riveted to the channel iron. Where the tramway crosses minor roads the conductor consists of a cable carried underneath the surface, and where the tramway crosses the main road from Armagh to Newry the conductor is carried overhead. The return circuit is through the tram rails, the rails being connected at the joints by wire or copper strips. The motors are of the Edison-Hopkinson type, and are placed on the front of the cars, and the gearing arrangement, although rather complicated, is working satisfactorily. No doubt the practice now being adopted on other lines of placing the armatures on the axles of the cars very much simplifies the working, but the Author imagines that it must be found difficult to keep the parts clean in such a position, and they are also more liable to suffer from vibration and inequalities in the road.

The rolling stock consists of three passenger cars, two of which are provided with motors in front, and numerous waggons. The waggons are designed with flangeless wheels, so that they can be drawn by horses from the terminus in Newry to the quays, and these wheels run, not on the tram rails, but on rails placed immediately outside them and at a slightly lower level. Of course the fact of there being four tram rails, as well as a central conductor, renders the arrangement of points and crossings extremely complicated, but otherwise no difficulty has been experienced in the working of the system. This tramway has now been open for traffic for the past ten years, and it is satisfactory to note that the cost of working and general expenses have been extremely small.

Time will not permit the Author to deal with horse tramways in our larger towns in Ireland, and he trusts that some Member with more experience of these tramways will present the Association with a paper on a future occasion.

Conclusion.

The subject of light railways and tramways in this country is a large one, and the need for them is great. Government has dealt liberally with Ireland in the past, and it is to be hoped it will deal still more liberally in the future. Further free grants to the poorer districts, and the issue of loans at 2 or 3 per cent. on a grand jury guarantee in every district, would probably be the means of doubling the tramway system of Ireland in a few years. In order, however, to make the Irish tramway systems popular and useful, it is necessary that the rates charged for the conveyance of goods and passengers should be as low as possible. To enable this to be done the working expenses must be reduced to a minimum. In this country—at any rate inland—coal is dear, but water is plentiful and can be rendered easily available for the working of turbines or other hydraulic machinery. The author therefore ventures to suggest that the motive power for the working of tramways in Ireland may possibly in the future be obtained most easily by electricity generated by means of hydraulic power, and he earnestly hopes that the close of the nineteenth century may witness the construction of light railways and tramways throughout the length and breadth of his native land.

DISCUSSION.

Mr. J. Perry : I wish to say a word or two in regard to this paper, and it may be convenient if I say that word or two before our English friends speak upon the paper. I have had a great deal to do with the light railways that have been assisted by the Government. I live in a part of the country which was nine or ten years ago very badly served with railways, but in consequence of this Act of Parliament, that was largely stimulated by Earl Spencer when Lord-Lieutenant, the district is very different to what it was ten years ago, and is now fairly well served. But I think the Government assistance might have been much more efficiently given. The arrangement was, as Mr. Dorman has explained in his paper, that the Government guarantee one-half up to 2 per cent. Now Government can get money at about $2\frac{3}{4}$ per cent., and in my

opinion if the Government had given the money at ¾ per cent. to a properly arranged authority in the district, the thing would have been much more economically done, and would have been much better for the district. The result of the arrangements set up by the Act of Parliament, was that we were thrown into the hands of financial speculators. Take the line from Galway to Clifden. There were a large number of applications for guarantees; ultimately it was made by the Midland and Great Western Railway; not one of the sets of speculators got it. The risk of such a thing could be provided against by Act of Parliament. In this country there was a precedent which might have served for the work, though, like most Government things in this country, it is capable of improvement. The drainage boards which are appointed to promote arterial drainage, would have been a much better model than the plan adopted by the Government when they passed this exceedingly foolish Act of Parliament. One point in favour of adopting the narrow gauge for light railways, is that the proportion of rolling stock to load carried is much smaller with the narrow gauge than with the broad gauge. That and greater liberty as to curves form the main advantages in the use of the narrow gauge. The narrow gauge costs pretty much per mile the same as the 5 feet 3 inch gauge.

Mr. Perry adds the following explanatory remarks to the discussion: I appear to Mr. Boulnois to have a different opinion from what I really hold. I desire to avoid any appearance of political bias in speaking of what either of the great parties when in power has done to benefit the poor and congested districts of the west of Ireland. Both parties have shown willingness to be of real benefit.

The Tramways Act provided a large sum of money for the construction and maintenance of tramways, and it appeared to be sound policy to bring in the local authority of the district and make it a partner with the imperial authority. If this idea is contrasted with the policy by which large sums were simply handed over to existing railway companies on condition that they would make, equip and work certain lines of railway, it would appear to most people that it is the sounder policy of the two, and that the second plan is sheer waste and extravagance. But this is not so; most people conceive of a local authority as being solvent and sound. In our western districts, where the poor rate is 4*s.* in the £, and county cess from 3*s.* to 4*s.* in the £ per annum additional,

where the workhouse buildings are falling to pieces because the ratepayers are unable to maintain them, the safest and most economical course for Government was that adopted in the case of the Galway and Clifden Railway and the other railways of the same character in Mayo and elsewhere. According to the early proposals, the Government agreed to pay 2 per cent. on the capital of the promotion company, but there was not sufficient care taken to make certain that the railway would be worth the money it appeared to cost, and Government, in paying 2 per cent. on capital, would in many cases be paying quite 3 per cent. on the value. In a solvent district, assuming the full guarantee to be called upon, Government would therefore, as a joint guarantor, be paying more as its proportion than the money is worth in the market, and the district would be paying its share besides. In Connemara, however, the probability was that the district would be unable to pay its share of the guarantee, and Government would have had ultimately in some shape to help the shareholders. Where I name Earl Spencer, my feeling is of respect and gratitude.

Mr. H. Percy Boulnois: I have very little to say about the paper read by Mr. Dorman. Of course it is absolutely new work to a great many of us, as light railways are practically unknown in England. With reference to Mr. Perry's remarks, I think he has been rather "looking a gift horse in the mouth." A great deal has been done in that way for Ireland, and in my humble opinion—without touching at all upon politics—the Government did what was wise. I think the reason that the local people did not take up the light railways, was more from want of enterprise than anything else. It is no fault of the Government that the railways were not made by local companies and local people. With regard to the question of cost, I should be glad to know what compensation was paid for the land, and in what way the compensation was paid—whether under the Lands Clauses Act or a special Act—and whether the land was dear or cheap. If the land was cheap it is a pity the lines were not made double, as the single lines make the conduct of the traffic difficult, and the service is not good. Comparing the light railways in Ireland with the tramways in Liverpool, there is a vast difference in the cost of construction. The tramways in Liverpool cost 6000*l.* a mile, and to compare that with the 1800*l.* a mile these light railways cost is strongly in favour of the light railways. I beg to propose a vote of thanks to Mr. Dorman for his paper.

Mr. E. Pritchard: I rise with pleasure to second the vote of thanks to Mr. Dorman for the paper he has given us. It is indeed a very interesting description of the existing light railways in Ireland, and the facilities which they offer. I, with Mr. Boulnois, rather think the Government have acted very fairly in this matter, but I do not venture to set my opinion against that of Mr. Perry, who is much better acquainted with the work that has been done. Still there must be a very great advantage in the adoption of light railways, not only in Ireland but in other places. The author has dealt with tramways as well as light railways in his paper, therefore I take it we may consider the question of tramways, their construction and working. The curves and gradients form an important point in connection with the cost of working. I notice the curves and gradients which the author mentions on the light railways are very much easier than what we are compelled to adopt in the construction of tramways. I have had to construct tramways—horse, steam, cable and electric—where the gradients have been more severe and the curves sharper, and I find with a good road no difficulty in having curves sharper, and gradients more severe, than the figures given. The lines I constructed in Birmingham have curves of 34 feet radius. The cars are upon bogie frames, and the wheel base is a very short one. If the wheel base is properly considered in connection with the curve, there is little difficulty in getting round it. The engines weigh from 9 to 13 tons, but the 13-ton engine is not satisfactory. The best engines on tram roads are those of Kitson, of Leeds: they do their work better than any other with which I am acquainted. I notice you are still running in Ireland the obsolete form of vertical cylinder with gearing. That form of engine was tried extensively in Staffordshire, Birmingham and the north of England, but has had to give way to the locomotive type. Kitson's engine has its cylinders well out and above the roadway, and there is very little to damage by the dirt and grit which is always likely to get into the working parts of a locomotive. Another advantage is that it is worked with the Kitson valve gearing, which is easy to get at, and the working parts are all outside the locomotive. Those engines are doing work on gradients of 1 in 16, and some of the curves, as already referred to, are as sharp as 34 feet radius. The condensation of the steam is easily effected, as they will carry one tank of water and condense their steam for 54 miles. The weight of the engine is

determined by the load it has to draw, but we find the 8-ton or 8 ton 10 cwt. engine will move itself up a gradient of 1 in 16, drawing a car of 4 tons *plus* a weight of sixty passengers. That is very good work indeed. Tramways are a great boon to the public. The Corporation of Birmingham have, under their private improvement schemes, taken a great portion of the central part of the town which formerly accommodated artisans, pulled down the houses and constructed wide streets; and the tramways have formed a great aid in supplying facilities for the artisans to get to their homes outside the city. We have got one company which is carrying thirty times the population of Birmingham per annum, with very few accidents, and at an enormous amount of receipts. I am very much astonished at the low cost of the light railways in Ireland—1000*l.* a mile is exceptionally low. I take it these figures represent the construction, and not the equipment of the line; the lowest figure at which I have been able to construct a line is at Magdeburg in Germany, where the land was given, and the line was constructed throughout at a cost of 1834*l.* per mile. That was only the permanent way and road construction. It may be that in Ireland the lines are constructed at a much less cost than in England. It would be interesting to know what has been given for compensation, whether the land has been given, and what has been paid for the right of easement. Tramways in England cost from 3500*l.* a mile, where there is no important paving to be executed, and where the rail is of light construction, up to 6000*l.* a mile, which latter sum was, I believe, the cost of the Liverpool track. I must say, however, that for horse traction I think the Liverpool road is one of the finest specimens of tramway construction I have seen. The cost of maintenance in many towns is very heavy. The cost of maintenance for some 14 miles of road in Birmingham has exceeded 10,000*l.* per annum—which is an enormous outlay for the company. The cost of construction of the tramways in Birmingham works out at 5000*l.* or 5500*l.* a mile, which is 500*l.* to 1000*l.* a mile cheaper than Liverpool. The weight of the rail in Birmingham is 98 lbs. to the yard, one of the heaviest of any tramway in the country.

Mr. Boulnois: The weight of the rail in Liverpool is 80 lbs. to the yard.

Mr. Pritchard: The heavier weight of the Birmingham rail is rendered necessary in consequence of the paving being 6 inches in depth. With regard to electrical traction, I agree with

Mr. Dorman that the overhead is the cheaper system, and now that the poles are made more ornamental, ought not to be objected to in any district. We have got one running in South Staffordshire, which is working very well, and has this advantage, that it does not require a network of overhead wires. If you take Leeds, which is a very good system, there is a perfect network of wires above you. In South Staffordshire the side contact system has been adopted. Birmingham will not permit the overhead system either in the city or in the suburbs, and consequently we could only adopt the accumulator system, with which I was associated as joint engineer with Mr. Kincaid. To work an ordinary tramcar we require approximately $3\frac{1}{2}$ tons of accumulators. As I mentioned the other day, the wear and tear is so great that the accumulators have only a short life. Until we have a dry accumulator or a greatly improved ordinary battery, it is impossible for any electric tramway or light railway to be worked successfully by this system upon a grooved rail. At the present moment there is a loss of about 2000*l.* per annum on a three-mile length of road in Birmingham. On the other hand, the overhead electric system is being worked by contract by the Electric Construction Company at a very low rate of cost for traction. I have known lines where the batteries alone have for a time cost an expenditure of 10*d.* per mile to maintain. As against that we have a less voltage than we should have if we were working with the overhead system and from the stations direct. We are allowed 200 voltage for the working of the tramway. With the overhead electrical system we can work a tramway pretty well as cheaply as with steam engines, and much more cheaply than with horses. Now a word or two with regard to cable traction. I have (in conjunction with my colleague Mr. Kincaid) constructed three miles of cable road double track in Birmingham. Prior to the construction of that work I went to America and visited every city but one where the cable system was in operation. When there, I obtained information as to what to avoid, not what to adopt. Therefore with regard to the construction of the line in Birmingham, the tramways company had to take the responsibility of the work and make a very heavy deposit. The line was costly to construct, by the necessity for the removal of large gas and water mains. A cable line may be constructed and equipped for from 10,000*l.* to 20,000*l.* (according to local requirements) per mile for a double road. The Birmingham line is somewhat on the lines of the

conduit laid in Chicago. It has now been working for seven years, and little or nothing has been required to be done at it. The road has an ascending inclination of 1 in 15 upon a curve with a radius of about 50 feet. In Birmingham, whilst the electric system is working for 118 per cent. of its receipts (a loss), steam, 73 per cent. of its receipts, the cable road is worked throughout at 45 per cent. of its receipts—I believe the cheapest worked road either in this country or America. The number of passengers has been great, and upon this road a profit of over 19,900*l.* per annum has been transferred to revenue account. It appears to my mind that the endless rope, with a properly constructed road, must be the cheapest. The cost is not more than an electric or steam road, if you take into consideration the equipment and a frequent service of cars. The cost of steam is $1\frac{1}{2}d.$ per engine mile for fuel. The consumption of fuel on a cable road is represented by $\frac{1}{2}d.$ per mile. One driver controls the whole seven miles of rope or steel cable, and there is no reason why there should ever be a cessation of working with ordinary care. There is no difficulty in guarding against a broken cable. The cable should be examined every night. One cable has run in Birmingham fourteen months, in Brooklyn nearly three years, in San Francisco twelve to sixteen months, while at Philadelphia the cables did not last longer than six weeks until the road was repaired. A good steel cable may be said to be worth a twelvemonth's life. I can only again say it is a very great pleasure for me to second Mr. Boulnois' proposition to accord a vote of thanks to Mr. Dorman for his paper. The paper is one which has a freshness about it, inasmuch as it brings new matter for our consideration in place of the constant recurrence of papers on sewage purification, sludge pressing and similar works.

Mr. Traill: First, briefly, I wish to welcome you to this district. This paper has opened up so many questions that it is very hard to dwell upon them, except a very few points. With regard to one question—the opposition that there has been to so many lines. In our case we have been subjected to most dreadful opposition. We were to a certain extent the pioneers of the narrow-gauge light railways. We were opposed by the town of Portrush, by the town of Bushmills, and the local railways; in fact, we had no one to say a good word for us. It took us two opposed Acts of Parliament, and we had to fight three days in the House of Commons to get our extension from Bushmills to the

Causeway. That threw a very great expense upon a line like ours. Then, we were the pioneers in the use of electricity, which has also thrown a great deal of expense upon us. Our worst gradients upon this line are 1 in 24, and our worst curve—I can beat all the records—is one of 30 feet radius.

Mr. Pritchard: We have one of 19 feet radius going into the depôt.

Mr. Traill: We have also one of 50 feet going round a semi-circle. Our method of working is very crude, as we began at an early stage of electrical locomotion. We began in 1883, and though our system does fairly, it might be very much improved. We also introduced the system of working by turbines to obtain our electrical power. Our traffic has so much increased that we have to supplement our electric working by steam working, so we are afforded a means of comparison between the cost of the two powers. Our average cost during the past twelve years for electricity has been $3\frac{1}{4}d.$ to $3\frac{1}{2}d.$ per train mile, and that includes what is not usually included in the train mileage, the conductor of the car. Now our steam train mileage for the same line, and for the same number of years, has averaged from 1*s.* 3*d.* to 1*s.* 4*d.*, so there is a very great saving by electricity. In some cases our steam engine is able to take a larger load than the electric car can carry.

Mr. Moore: I wish to say a word or two on this paper, as the surveyor of a county which has no light railways. There were five or six schemes proposed for the construction of light railways in Meath, but the Grand Jury threw them all out on the question of the guarantee. They have not only to guarantee 2 per cent., but if the line fails to pay and becomes derelict they have to take it up and work it. In Kerry, in consequence of a serious accident on the Tralee and Dingle Light Railway, the baronies were rendered nearly bankrupt and had to get a grant in aid from Government. A light railway was proposed from Kilmainham Wood in Meath to Bailieboro in Cavan, of which eight miles were in Meath and four in Cavan. The Meath district was almost uninhabited, and practically all the parties benefited lived in Cavan, but the Meath Grand Jury were asked to guarantee in proportion to their mileage, which they, of course, declined to do, and the scheme fell through. One of the disadvantages of light railways to which no reference has been made can be seen on the Blessington and Lucan line. Going along the road from Dublin, a number

of stones have been put up by the side of the road which might be taken for milestones, but they are not: they are stones erected asking the passer-by to pray for the soul of the person who was killed there by the railway. The people are getting more used to the tramway now, and there have not been so many killed lately. The Lucan steam tramway has been made on the road itself. This is the worst position possible, and the directors are raising 10,000*l.* to reconstruct the line on the side of the road. With only 18 feet clear on the roadway, if two vehicles have to pass, one of the horses would have to be very near the tramway, and an accident might happen. The Dublin and Garristown tramway was thrown out by the Dublin Grand Jury by 14 votes to 9, entirely on the question of the guarantee. I wish to show you why the Grand Juries do not like to guarantee these lines and the difficulties which have arisen in the matter.

The vote of thanks to Mr. Dorman was unanimously accorded, but Mr. Dorman was not present to reply.

DESCRIPTION OF THE HEAD-QUARTERS OF THE BELFAST FIRE BRIGADE.

By JAMES MUNCE, Assoc. M. Inst. C.E., Mem. San. Inst., Assistant City Surveyor.

Up to 1892, the staff of the Belfast Fire Brigade was composed of six permanent men, and 29 auxiliary men who gave their services when called upon, making a total of 35 available in case of necessity. During the day, as the auxiliary men were scattered over the city engaged at their ordinary avocations, messengers had to be despatched on cars for them ; and at night these auxiliary men had to be called up from their houses about 300 yards from the station. The horses were hired by contract, and stabled on the premises, but as they were frequently changed they could not be expected to show much intelligence. It will be seen from this that some considerable time might elapse between the receipt of an alarm and the concentration of the whole strength of the brigade upon a fire.

The urgent necessity for continuous improvement in this department of Belfast municipal work will be seen from the following table, which shows the increase in the number of dwelling-houses, and of the valuation for rateable purposes, and consequent increase in risk, since 1891. (The figures for the years 1862 to 1891 inclusive have been given in a paper by the City Surveyor, published in the Proceedings of this Association, vol. xix.)

Year.	No. of Buildings erected.	Valuation of City on 1st Jan. of year.
1892	2212	£737,816
1893	2533	761,840
1894	2538	792,127
1895	—	844,714

The Corporation decided, on the resignation of the late superintendent after 40 years' service, to look into the whole question of the fire protection of the city.

The present superintendent, Mr. Parker, who was appointed in 1892, after considering the matter fully, reported that in his opinion a permanent staff should be appointed and the chief station rearranged. This report was endorsed by a special committee, adopted by the Corporation, and a permanent staff appointed which now numbers 50 men. The Author was instructed to confer with the superintendent, and prepare the necessary plans for additional accommodation.

The old station, opened in 1872, occupied a portion of the present site. It consisted of house for superintendent, a shed for fire engines, a two-story building containing stable and driver's room on ground floor, with firemen's room and workshop above, and an enclosed yard.

As it was found impossible to convert these buildings into a station suitable for the accommodation of a permanent staff, with the necessary facilities for prompt turn-out, &c., sketch plans for an entirely new station were prepared and laid before the Corporation, who decided, after much consideration, to erect it.

The Author and superintendent were directed to visit some of the larger towns in England and Scotland, so that advantage might be taken of their experience, before the contract drawings were prepared. The chief object in view was to ascertain what to avoid. About twenty stations were visited, and without exception the men complained of their quarters being confined and unfit for the accommodation of families. Firemen's children, like our own, do not remain babies, and accommodation sufficient for a family of small children is quite inadequate when they grow up. For this reason we were told many good men have been forced to leave the service and forfeit their pension rights. London is specially faulty in this respect.

The site of the new station is shown by old maps to have been at one time the foreshore of the river Lagan; at a later date it became the site of a dock, afterwards a market, and for 25 years past it has been covered with buildings.

The opening up of the foundations revealed two very interesting facts. A concrete foundation 4 feet 6 inches wide, 2 feet thick, with two longitudinal timbers 12 inches by 6 inches on edge, and cross sleepers spiked to the longitudinals, embedded in it in the usual way, was found to have broken right across both timber and concrete like a pipe stem, showing the very yielding nature of the sub-soil, as the buildings were only one story high. This

foundation had been laid in 1870 to carry a high building, but the Author decided, on examination, to remove it altogether, and put in a new piled foundation. The excavation for the tower foundation, which is carried down 15 feet below the surface, showed that it takes *more than three* years to render bad filling innocuous. The smell was so bad that the workmen complained bitterly, yet this site had been filled more than 40 years.

The new buildings of the station comprise dwellings for 25 men, with laundry and workshops, residence for superintendent, offices, duty-room, engine room, gymnasium, quarters for single men, six-horse stable, hose tower, boiler house and dynamo room. The old buildings have been converted into stables, stores, &c.

The buildings enclose a drill yard, and are arranged fronting three streets. The main buildings are in Chichester Street, which is 80 feet wide and a leading thoroughfare. At the left side of the frontage is the gateway leading to the drill yard. It is made wide enough to admit a load of hay, and is the only entrance to the interior, except through the engine room or duty room.

The foundation is formed of piles and concrete. Larch piles 40 feet long, 12 inches diameter at base and 8 inches at point, were driven down and sawn off level; a layer of old roofing felt was placed on the bed of the trench, to prevent the cement mixing with the sleetch. (Wood was specified in first contract, but was found unsuitable owing to the yielding nature of the bottom.) Portland cement concrete was then filled in to the level of pile heads.

Cross sleepers 12 inches by 6 inches were spiked to the pile heads and concrete filled in to their top surface; longitudinal sleepers were spiked to these, and the concrete brought up 6 inches above their top edge. On this the footings of brickwork in cement were built to ground line. The superstructure is of perforated bricks and mortar; solid Annadale bricks were used for the external facing of the engine-house block. There are 49 piles under the tower, and 490 under the remainder of the building.

The buildings have been constructed in brickwork with the exception of the engine-house block; the external facing is of ordinary red perforated facing bricks.

The engine house occupies the main portion of the front, and is 65 feet by 35 feet in the clear, and 16 feet 6 inches to ceiling. It consists of five bays, each with a door 9 feet 3 inches wide and 12 feet high, so that an engine can pass out with the horses at full gallop. The doors are framed in four leaves, glazed in the

upper panels with plate glass having the city arms ground on. The engine house is a clear span of 35 feet, this width being absolutely necessary to give sufficient space for working round the machines inside. The floor and roof are carried by steel girders formed of two 16-inch by 6 I joists, with ½-inch plates riveted on top and bottom. The front wall is carried over gate openings by steel girders formed of three joists and plates. The facing of the piers is of brown glazed brickwork with Castlewellan granite bases. A brass brick with screw plug is fixed in each pier so that the gates can be left open, and a rope fastened across in summer to hooks which take the place of the plugs.

The bay next superintendent's house is screened off as a duty room by a wall 5 feet high, above which a clear glass screen rises to the ceiling; in this is fixed a clock with a dial on each side, so that the duty man and engineer can note times of departure and arrival of machines or men.

The walls are lined with enamelled bricks of various colours, and the ceiling is of pitch pine, varnished.

The floor of the engine house is of Dutch clinkers laid diagonally. The stable floor is similar, but has 4-inch granite cubes in the stalls.

Immediately behind the engine house is the stable. The stalls are arranged so that the centre line of each pair is opposite the centre line of a gate. The doors open into the engine house, and are fitted with galvanised rollers at the angles so that a horse rushing out cannot be injured. Teak rollers were used at first, but the horses destroyed them by their teeth. At one end of the stable a washing place is provided where horses and machines can be washed under cover. It is also lined with glazed bricks.

The gymnasium and single men's quarters are located over the engine room and duty room. The gymnasium is 39 feet by 35 feet by 16½ feet high. It is used as a reading and amusement room for the men, and a sleeping room for the men on night duty.

The flat roof of the stables forms a promenade for men off duty, and is the approach to the gymnasium, &c. It is reached by a spiral staircase at one end. The flat roof of the gymnasium forms a drill ground, and is also used as a promenade by the men.

The tower is situate behind the duty room. It is 103 feet high, and combines a chimney from boilers, ventilating shafts from stables, engine house and gymnasium, wire passage, electrical test room and hose-drying tower. It can also be used for look-out

purposes. The hose used in Belfast is in 50-yard lengths, and can be hung up without a kink. The tower is approached by an outside iron spiral stair, and has a wrought-iron balcony all round, at level of testing room, which enables the men to deal with the wires without risk. Hooks and pulleys are attached to balcony at one side for drying hose in the open air.

All telephone wires and fire alarms are received in a room at top of tower, from which they are led down a tube to the switchboard in duty room.

The quarters for married men are arranged round two sides of the drill yard. Each house is complete in itself, and consists of kitchen, bathroom, water-closet, and one, two or three bedrooms. They are so arranged that one room can be taken off any house and added to the adjoining house to suit the number of occupants. There are two-roomed, three-roomed, four-roomed and five-roomed houses at present. Each house is on one floor, i.e. there are no stairs in a house. Those on the upper floor are approached by a balcony formed of concrete on steel joists, built into the walls, with an iron railing, and stairs at each end and centre.

The laundry and coal vaults are in the centre of the block at the corner of Town-hall and Oxford Streets. The workshop occupies two stories at the end nearest the engine house.

All the buildings are covered with flat asphalt roofs, so that they can be raised hereafter without disturbing the occupants. The roofs over the dwellings form a playground for the children, who are not permitted to run about the drill yard. Each house is provided with a supply of hot and cold water. The hot water is laid on from a cistern placed on roof over the coal vaults, and the cold water is supplied direct from main. A dresser is fixed in each kitchen. The sink is of enamelled earthenware, and is fitted with a wooden cover which forms a table when not in use. The walls are plastered in Portland cement for 3 feet in height. The floors of the kitchen and bathroom are laid in red and black tiles on concrete. The bedroom floors are of wood. All are deafened.

The laundry is arranged so that five families can use it at once. The fittings consist of five washing stalls, each containing washing tub, boiler, scrubbing bench and drying horse (all screened off so so that one person cannot see the clothes being washed by another), a hydro extractor, washer, wringer, box-mangle, ironing table and iron heating stove. Hot and cold water and steam for boiling are laid on. The fittings are all by Messrs. Summerscales, of Keighley.

The workshop contains on ground floor a fitter's bench, coach-maker's hearth and anvil, drilling machine, lathe and an 18 horse-power vertical engine. The upper floor is used as a carpentry and painting shop. A travelling crane capable of lifting 10 tons is fixed to raise an engine to the upper floor, and is so arranged that if a fire alarm is given it can be left in any position with perfect safety. A boiler well is constructed in the ground floor.

A drill balcony 70 feet high is erected at one side of yard. It is of timber and represents two bays of six story building. It is used for training the men to climb, use escapes, &c. A water main fitted with numerous hydrants is laid in drill yard, and kept charged at high pressure.

The gymnasium is fitted with bridge ladder, scaling ladder, vaulting horse, parallel bars, horizontal bars, dumb bells, rings, climbing ropes, &c. Boxes and tables to cover the apparatus are arranged round the walls, and form seats by day and beds at night for men on duty. Bookcases are at one end, and a piano occupies a corner. The floor is laid like a ship's deck, and caulked so as to be perfectly water-tight.

The whole area of the buildings is covered with Portland cement concrete 6 inches thick, and Limmer asphalt below the floors.

The stable fittings are by Messrs. Musgrave. A brass rail is hinged at end of each stall to prevent the horse backing out. The heel posts rise to ceiling and support roof girders. A ventilator runs the whole length of the ceiling and joins flue in tower. The channel is flushed by a concealed water pipe in wall at one end.

The system of electric bells is so arranged that the duty man can call any individual, or by turning a lever, the whole staff at once; a sick man or one off duty can be left undisturbed.

The station is lighted entirely by electricity, the current being generated on the premises. A very compact Lancashire boiler made by Galloways, of Manchester, supplies steam not only to the engines for driving the dynamos, but also to a separate engine for the workshops, for boiling hot water in the cistern which supplies each of the twenty-five houses, laundry, single men's quarters and superintendent's house, and steam to the heating coils in duty room, engine house, gymnasium, &c. It is kept at about 40 lbs. pressure during the day, and at 80 lbs. whilst the electric light is turned on to the whole station, i.e. to 11 P.M. The exhaust steam is used for heating the feed water which is pumped into the boiler by a Worthington pump, through a superheater. The consumption of

fuel has been as low as 30 cwt. per week, which the Author ventures to think is remarkable, and is due to careful attention and firing.

The dynamos are driven by two high-speed engines built by Mr. W. Malcolm, of Belfast. Each engine is capable of developing about 18 horse-power, but the average load is about 10 horse-power for each. The dynamos, which are the production of the contractor for the electric light, Mr. J. H. Greenhill of Belfast, are placed on the same bed plates as the engines, and are driven by belts from the respective fly-wheels. To avoid any risk of failure in the lighting either machine can be instantaneously connected to any particular circuit by means of a very complete double pole, double break "throw over" set of main switches, also made by the contractor. There are three main circuits, termed the "ordinary," the "all-night" and the "emergency," and these terms explain their purpose; the "emergency" being switched on when there is a call of fire. The switchboard is placed in the duty-room, and although at first sight it appears very elaborate, it is in reality extremely simple to manipulate, and renders it totally impossible for a mistake to be made. It contains all the Corporation's telephone wires, the direct fire alarms, bells to each apartment and dwelling in the station, electric-light switches, speaking-tubes, &c., also gauges showing the pressure of the town water supply, and the electric-light volts and amperes. In short, the duty-man at the switchboard has control of the lights, bells and telephones of the whole establishment and the out stations as well. The ordinary lights are switched out at 11 P.M., but there is an additional switch for each lamp in the dwelling-houses and in other sections, by which any lamps not required may be cut off. When the fire alarm rings the "emergency" switch is operated, and instantaneously the special lights in the fire-engine room, stables, single-men's quarters, and one light in each of the married-men's houses are illuminated, so that no delay occurs in any section from want of light. These "emergency" lights are controlled from switchboard only. The current is on the direct low tension principle, and in addition to about 170 incandescent lamps there are two very powerful arc lamps for illuminating the open spaces of the station. The general effect of the lighting is extremely fine, and it has proved to be extremely satisfactory after two winters' experience.

The gymnasium and single-men's bedrooms have polished steel shafting fixed as poles for the rapid descent of the men to the

engine house. The engine house and stable doors are fitted with Try's patent fittings. Gas lights are hung at each side of each engine for igniting the lamps. The flames of these are mere specks until taken in the hand, when they enlarge to the size of No. 2 gas-burners. When released they rise above the men's heads and resume the small flames. The harness is suspended and becomes free on the weight being taken by the horse.

At 11 P.M. all lights (except those known as "all-night lights") are turned out by the man on duty at switchboard. The other men on duty lie down in the gymnasium on stretchers with rugs round them.

When an alarm of fire is being received, whilst the telephone is at his ear, the duty-man turns one handle. This operation lights up the bedroom of every man, the engine house and stable, single-men's quarters and gymnasium; then the bells ring, the men on duty slip down the poles, and the first man pulls a cord which releases the stable doors, the horses trot out and get under the harness; during this time the driver takes his seat, and the moment the engineer sees all right he pulls a cord releasing the doors, and in less time than is occupied in describing it, the first machine is off, *only fifteen seconds* (*on the average day and night*) having been occupied between the receipt of the alarm and the engine responding. Immediately another machine, men and horses take the place of those gone out. Of course, if the fire is an extensive one more machines follow.

In planning the buildings the points kept in view were convenience and economy in working, facilities for prompt turn out, comfort of men, and provision for future extension without undue interference with the working of the station.

The latter has unfortunately for many towns been neglected, and in consequence increased accommodation can only be obtained at enormous expense. The total cost of the station and fittings, exclusive of land, has been under 20,000*l*.

The contracts for the work have been carried out by the following firms:—

Buildings, Messrs. W. J. Campbell & Son, Belfast, and Messrs. Fitzpatrick Brothers, Limited, Belfast.

Stable fittings and stairs, Messrs. Musgrave & Co., Limited, Belfast.

Heating and balconies, Riddell & Co., Belfast.

Plumbing, H. M'Cloy, Belfast.

Electrical work, J. H. Greenhill, Belfast.
Machinery workshop, Messrs. Combe, Barbour & Combe, Belfast.
Steam engines (3), W. Malcolm, Belfast.
Laundry fittings, Sommerscales & Co., Keighley.

DISCUSSION.

The PRESIDENT: Gentlemen, we have had a very interesting paper, and one that there might be a good deal said upon. I have myself taken a very great interest in fire brigade stations, and I have visited the station which Mr. Munce erected at Bootle. It is perfectly arranged for the speedy turning out of the men and the engines. I was there the other day when notice was given of a real fire, and the brigade turned out in rare style.

Mr. H. PERCY BOULNOIS: I have very few remarks to make on this paper of Mr. Munce's. It is a very interesting paper, and will be most useful to us. If any of us have to construct a fire brigade station, we should be able to refer to this paper and get most valuable hints as to the whole of the buildings and the arrangements necessary. With regard to Mr. Munce's statement as to refuse smelling after being covered up forty years, it is quite true that the celebrated Dr. Parkes, the sanitarian, and the late Dr. French, Medical Officer of Liverpool, said there was no nuisance or danger from organic matter which had been buried for three years. But that was house refuse deposited where the air could get at it. The refuse referred to by Mr. Munce had been put on bog land where aeration could not go on, and where offensive matter might remain offensive for many years. It is exceedingly interesting to find that the foundations were so bad, and that they had such great trouble in making the piled foundation. I should like to hear whether there have been any settlements in the building since its erection. I have much pleasure in proposing a vote of thanks to Mr. Munce for his very valuable paper.

Mr. R. GODFREY; I have great pleasure in rising to second the vote of thanks to Mr. Munce for his paper. As Mr. Boulnois said, it contains about all we want to know with regard to fire brigade equipment. I am very pleased that Belfast has taken such a lead in establishing a permanent fire brigade. The time has come when fire brigades want to be made a permanent institution. It is the greatest mistake possible to have policemen acting as firemen;

the fireman's training is as important as the policeman's. I hope the time will come when it will be compulsory upon every authority to protect the public against fire as against any other evil. I have established two fire brigades, and I have always protested against having to go round with the hat to provide means to purchase a fire engine.

The vote of thanks having been accorded,

Mr. MUNCE, in replying, said: I am very much obliged to the Members for this vote of thanks. The paper was prepared at the request of my friend Mr. Robinson, and I do not think I could have done less, for he made a special visit to Belfast to ask me. In reply to Mr. Boulnois' question, I may say that the only settlement which has appeared in the building is at the side of the door nearest to the dynamo room, where there is a slight crack. If an expert were to go round he might find it, but I do not think any one else could discover it. As I had seen one or two of the London Fire Brigade stations, and noticed how the glazed bricks had chipped, I put a clause in the contract making the contractors responsible for any such damage. Mr. Parker, who has had a very large experience, tells me that a great deal we hear about America is not quite true, whilst a great many of the things done are only for show and not for practical work. What we have done in Belfast has been done for practical work. When Captain Shaw visited the station, he said he thought our engine room was better adapted than any they had in London, owing to its being quite free from pillars or other obstructions.

The PRESIDENT said: After the very interesting business of this meeting—and we have now reached the end of the business—we ought to record on our minutes a vote of thanks to Mr. Robinson, of Londonderry, for the way in which he has prepared for the meeting and carried it out, and also to Mr. Dorman, our local honorary secretary.

Mr. J. LOBLEY: I second the vote of thanks to Mr. Robinson with great pleasure. We are all much indebted to him for the manner in which he has looked after our comfort. I can corroborate what was said about "show," in connection with fire brigade work in America. I was in Montreal when there was a competition of fire brigades on a large piece of ground near the City Hall, and I can safely say we never see anything so showy in England. They will also submit to many things in America which would not be tolerated in this country. When the cable tram line was laid

in Broadway, New York, they had the roadway up for several miles in length, and for the most part the entire width from curb to curb, in order to re-arrange the water, gas, steam, hydraulic and other mains.

The Members then proceeded by the electric tramway to the Giant's Causeway, where they were entertained to luncheon at the Causeway Hotel by Mr. R. H. Dorman, Honorary Secretary for Ireland. The Bishop of Cork and Mrs. Meade were amongst the guests.

After luncheon the principal points of interest in the far-famed Causeway were explained by Mr. Traill, who also acted as cicerone on the visit to the picturesque ruins of Dunluce Castle.

DISTRICT MEETING AT WESTMINSTER.

February 21, 1896.

Held at the Institution of Civil Engineers, Westminster, S.W.

C. H. Lowe, M. Inst. C.E., Vice-President, *in the Chair.*

The following papers were read and discussed.

SOME SUGGESTED AMENDMENTS OF THE METROPOLIS LOCAL MANAGEMENT ACTS.

By J. PATTEN BARBER, M. Inst. C.E.,
Islington.

As the object of this paper is to consider only those portions of the Metropolis Management Acts of 1855 and 1862 which relate to matters connected with a surveyor's work, reference to the Amendment Acts of 1856 and 1875 is omitted, and the two Acts referred to throughout the paper will be the Metropolis Management Act, 1855 (18 and 19 Vict. c. 120) and the Amendment Act of 1862 (25 and 26 Vict. c. 102). It will be convenient if these Acts are referred to respectively as the first and second.

The first Act had been in operation nearly seven years before any Act amending it or giving extended powers to the authorities constituted by such Act was passed. The Act was then amended and extended by the second Act, which came into operation in August 1862.

It could hardly be expected that such an Act as the first, which dealt with such an extensive area and a large number of subjects

affecting a great variety of interests, should be perfect; and it was no reflection upon the skill and experience of the framers of the measure when it was found necessary in 1862 to pass an amending Act, to meet the difficulties, and supply the deficiencies, which had been discovered during the seven years' working of the first Act.

Although, with the exception of two short Acts passed in 1890, no attempt has since been made to amend the two Acts referred to, it is not because the necessity for more definite and comprehensive powers has not been felt by those who have to administer these Acts, and it is somewhat surprising that, considering the advance which has been made since 1862 in most of the works connected with municipal and sanitary engineering, there should have been no movement made by metropolitan local authorities to bring the Acts under which they work nearer to the standard of present-day legislation.

Some of the authorities have no doubt found the insufficiency of the two Acts, but, in order to obtain powers more suited to present requirements, the co-operation of the majority of metropolitan Vestries and District Boards would be necessary. It might, perhaps, be difficult to secure this, but the Author believes that the reasons for either an amended or a new Act are sufficiently strong to induce a majority of the Vestries and District Boards to combine for the purpose of securing the necessary legislation.

For the purpose of calling the attention of metropolitan surveyors to some of the matters which he feels are insufficiently dealt with in the two Acts, and to the want of more definite and comprehensive powers respecting the works which come under a surveyor's control, the Author has prepared this paper.

Sewers.

Before any person can begin to construct a sewer, a plan and section thereof must be submitted to the Vestry or District Board, and their consent in writing obtained to the proposed work. This consent, however, cannot be given until the Vestry or District Board have submitted such plan and section to the London County Council, and obtained their approval thereof in writing.

It is difficult to understand the necessity for the approval of the Council in such matters, except it be to give them control over the

size and inclination of sewers in order to enable them to limit the quantity of sewage and rainfall discharged into the main sewers under their jurisdiction. As, however, the various districts must be efficiently drained when built upon, a limitation of the quantity of water discharged therefrom would prevent that object being attained; and it seems undesirable that the power to control the sizes and inclinations of sewers with a view to imposing restrictions as to the quantity of water to be discharged into the main sewers should be continued. It is suggested, therefore, that the power of approving plans and sections of sewers to be constructed by any person other than the County Council should be vested in the Vestries and District Boards; and, as the future maintenance of such sewers devolves upon the Vestries and District Boards, they should have power to require them to be constructed in accordance with specifications and detailed drawings of the sewers, manholes, gullies, &c., prepared by their surveyors; also that the construction of such sewers should be under the control and supervision of the surveyors, and that the cost of such supervision should be paid by the persons at whose expense the sewers are constructed. Plans and sections of all such sewers should be forwarded to the London County Council to enable them to keep a record of the sewerage system of the metropolis.

The obligation on Vestries and District Boards to ventilate and cleanse the sewers vested in them, sections 71 and 72, first Act, should be extended to the London County Council as regards main sewers. The ventilation of the latter being, in many cases, effected through the sewers under the control of the Vestry or District Board and the ventilating shafts provided by them for the ventilation of their own sewers.

The provisions of section 204, first Act, and of section 68, second Act, prohibiting the erection of buildings, walls, fences, &c., upon, over or under sewers without the consent of the authority in whom the sewers are vested, should be extended so as to enable the authorities to make and enforce conditions under which such buildings, &c., may, with their consent, be erected. Power should also be given to the authorities to prescribe the manner in which the foundations of walls and buildings near sewers shall be formed, and the depth at which they shall be laid, in order that the work of reconstructing such sewers may not endanger the stability of the walls and buildings near them.

Gullies.

By section 71, first Act, the Vestries and District Boards are compelled to trap gullies, including those discharging into the County Council's main sewers, although by section 27, second Act, the last-mentioned gullies cannot be trapped without the consent of the Council or of their engineer. A better arrangement would be that the Council should be compelled to trap all gullies vested in them. At present there is a curious mixture of duties respecting the Council's gullies; the Vestries and District Boards are obliged to cleanse the gratings, to remove deposit from and to trap the gullies, whilst the Council maintain both gratings, gullies and drains therefrom. Probably the best way of dealing with the whole matter would be to vest the gullies and all things appertaining thereto in the Vestries and District Boards.

Drainage of Existing Houses.

The extensive powers conferred by section 73, first Act, with respect to drainage works and sanitary arrangements in existing houses, are rendered inoperative by the introduction of the expression "sufficient drain." The purpose of the section is evidently to enable the authorities or their officers to require the construction of such works as may be necessary for the perfect drainage of a house, and the provision of all necessary sanitary appliances; but its whole force is dependent upon the construction placed upon the expression "sufficient drain." The word "sufficient" seems to be applicable only to the *size* of the drain, and it therefore appears that, however bad the drains of a house might be, the provisions of this section could not be enforced unless the drains were too small. An alteration of the section, giving to the authorities power to put its provisions in force in all cases where houses were found not to be drained or fitted with sanitary appliances to their satisfaction, would make it a most useful one.

Drainage of New Houses.

The intention of section 75, first Act, is that no house or other building shall be built or rebuilt, nor occupied, unless drains and other connected works have been provided to the satisfaction of the surveyor to the local authority. But the words with which

the section opens are so weak as to be altogether ineffective in preventing the acts against which the section is directed. Instead of the expression "it shall not be lawful," words should be introduced forbidding the acts referred to, and there should be a penalty for a breach of the provisions of the section.

Drainage into cesspools, which is permitted by this section, should be prohibited.

Section 76, first Act, contains the provisions by which the making of drains and their accessories, as well as the other works and apparatus (except water closets) connected therewith, is controlled by the Vestries and District Boards. It places very extensive powers in the hands of these authorities for prescribing the materials of which the drains, &c., shall be constructed, the manner of laying or fixing them, their direction, form and workmanship; and gives the authorities control of the works during their construction. Notice must be given to the Vestry or District Board seven days before commencing the work, and they must make their order respecting the same within fifteen days after the receipt of such notice. No provision is made requiring that either plans or sections of the proposed works shall be submitted, although these are usually demanded; should they be refused it is not clear that their production can be enforced. It is often impossible for an order to be made within the time required by section 76 of the first Act, viz. seven days, or the fifteen days specified in section 53 of the second Act. In order to avoid drawing up an order specifying all the details of the work in each case, the Author's Vestry have adopted regulations relating to drainage and sanitary fittings, and have ordered that all such work shall be carried out in accordance with these regulations. This, it is believed, is the course generally adopted by metropolitan authorities. Section 83, first Act, is, however, the only place in which the word regulations occurs, and, as there is no provision in either of the two Acts referred to in this paper, empowering Vestries or District Boards to make regulations as to drainage and sanitary works, it is frequently contended that the regulations which have been made cannot be enforced. The power to make bye-laws as to drains is, by section 202, first Act, conferred on the London County Council, but no such bye-laws have yet been made by that body.

Sections 76 and 83, first Act, appear to recognise the power of the Vestry or District Board to make orders and give directions only with respect to new drainage and sanitary works, and it is

doubtful whether they can exercise similar powers with regard to the reconstruction of drains.

The Author is of opinion that new legislation is required with regard to all drainage and sanitary work, and that a complete code of regulations governing the entire procedure with respect to such work should be drawn up and made applicable to the whole of the metropolis, giving the Vestries and District Boards control over both the construction of new, and the reconstruction, relaying or refitting of existing work. The Author does not consider that these regulations should be drawn up by the County Council, as that body has no experience in the carrying out of regulations relating to this subject. A committee formed of surveyors to metropolitan local authorities would be, in the Author's opinion, better able to produce a satisfactory and efficient set of regulations.

Drains Under Roads.

The Vestry or District Board is empowered by section 78, first Act, to make that portion of every private drain which is under a road, and to recover the expenses thereof from the owner of the house, building or ground to which such drain belongs. A provision is required giving the authorities power to apportion the cost of making or of reconstructing a drain used for the drainage of several houses upon the owners of such houses, and to recover the apportioned cost from such owners.

Paving, Draining and Repairing Courts, etc., not being Thoroughfares.

Section 99, first Act, places the duty of paving a court, passage or public place, not being a thoroughfare, upon the owner of any adjoining house, provided the freehold of such a court, &c., is vested in such owner, and the Vestry or District Board deem such paving necessary. No provision is made either for the drainage of the court or for the future maintenance of the paving, nor for the execution of the paving work in the event of the freeholder neglecting to do it.

The Author has not succeeded in putting the provisions of this section in force, on account of the difficulty of proving that the freehold of a court is vested in the owner of any adjoining house, or of finding any freeholder at all to such court. It has also been

found that there may be as many freeholders as houses in a court, each having the freehold of part of the court.

The next section contains more ample provisions for the paving, draining and repairing of courts not being thoroughfares, but the Author has found it quite as impossible to take advantage of this as of the preceding section, on account of it placing the duty of carrying out the necessary work upon the *owner of the court.*

The 99th section might be repealed and the responsibilities now placed by section 100 on the owners of courts might be laid upon the owners of the houses and lands abutting thereon, and, instead of rendering such owners liable to penalties for not carrying out the work, the Vestry should be empowered to do the necessary work and apportion the expenses incurred thereby upon the owners, and to recover such expenses in the same manner as those incurred for repairs to new streets under the Metropolis Management Amendment Act, 1890.

New Streets.

Section 105, first Act, enables the Vestries and District Boards to pave new streets at the expense of the owners of property abutting thereon; as, however, it does not empower the authorities to provide the necessary gullies in such streets at the expense of these owners, the section needs amending to remedy this defect.

Breaking up Streets.

With the increasing number of openings in the roads for gas, water and other purposes, the sections relating to this work require amending, and enlarged powers should be conferred upon the local authorities for controlling the opening and reinstating of the roads. Too little control over these matters is at present allowed to the authorities, and the restrictions and obligations respecting openings in roads are not sufficiently definite and stringent. Having regard to the safety and convenience of the public, and to the expense which may ultimately devolve upon the local authorities in consequence of the opening of the roads, it is necessary that the work should be carried out in entire conformity with conditions drawn with a view to the prevention of danger and inconvenience to the public and expense to the local authorities. The following are the principal requirements which are needed under this head:—

That no new mains or pipes, &c., be laid, no new pipes substituted for existing pipes until plans thereof have been submitted to and approved by the local authority.

The positions and depths of mains, pipes, &c.; positions of valves, hydrants, meters, &c.; as well as the description of covers to valves &c., should be subject to the approval of the local authority.

The extent of road which may be opened at one time should be fixed by statute, and the duty of fencing, lighting, and watching the road occupied by the work provided for.

The local authority should have power to prescribe the manner of opening and reinstating roads; the work should be done under the supervision of their officers, and to the satisfaction of their surveyor. The expense of such supervision should be paid by the persons opening the roads.

Persons opening the roads should be required to keep in repair so much of the roads as may be affected by such openings for twelve months after the openings have been filled in.

Subject to the preceding provision, power should be given to the local authority to repair openings in roads when such repairs are found necessary, and to recover the expenses from the persons by whom such openings were made.

Works abandoned or suffered to fall into decay; to be removed by owners at request of local authority, who may, in case of default, remove same and recover the expenses from the owners of such works.

In the event of alterations in line or level of road; mains, pipes, &c., to be altered as required by local authority at expense of owners of such mains, &c.

Private Paving.

Owners of private paving adjoining the public way should, on being required by a Vestry or District Board, be compelled to alter the levels of such paving so that it shall coincide with the paving in the public way. Such a provision is frequently found necessary when the paving in a road is repaired or altered in level.

Projections.

Section 119, first Act, empowers Vestries and District Boards to require the removal of projections made since January 1, 1856, but they could not enforce such removal unless they satisfied the magistrate before whom the person who had neglected to comply with the notice requiring the removal of projections appeared, that

such projections were an annoyance, or endangered or rendered less commodious the passage along the streets. However large or unsightly projections into or over a street may be, their removal is impossible so long as they do not endanger or obstruct the passage along the street.

It is necessary that the Vestries and District Boards should have power to prohibit all projections into or over streets, and to make regulations for controlling such as they may be willing to sanction.

Temporary Closing of Streets.

Power should be given to Vestries and District Boards to close streets during the execution of repairs or the construction of sewers, without having to obtain the consent of the London County Council, who cannot have such knowledge of the requirements of the traffic along the streets as the local authority.

Street Improvements.

By the provisions of section 72, second Act, the Vestry or District Board can only carry out works of street improvement in their district after having obtained the sanction of the London County Council thereto. It must be evident that the local authority is better able to judge of the necessity for such improvements than a central authority formed of representatives from all parts of the metropolis, many of whom have, in all probability, never seen the streets in which improvements are contemplated by the Vestry or District Board; the necessity for obtaining the consent of the central authority to such improvements is, therefore, a useless interference with the powers of the local authorities.

Acquisition of Property.

Section 151, first Act, gives power to Vestries and District Boards to purchase property for the purpose of constructing any works which they are authorised to execute under that Act, also for use as depôts, yards, &c. There is, however, no power given to take property compulsorily; in fact, this power is, by section 152, expressly reserved for the London County Council, although there

appears to be no reason why it should not be extended to Vestries and District Boards, who would, as the law now stands, have to incur the expense of obtaining a special Act of Parliament in the event of property being required for the purposes referred to which could not be obtained by agreement with the owners.

DISCUSSION.

Mr. W. Weaver: As an old metropolitan surveyor it gives me great pleasure to see, what I may call, comparatively speaking, the younger metropolitan Members taking the very great interest in their work which Mr. Barber must have done to prepare a paper on this subject. The preparation of a paper of this description requires a good deal of study and attention, not only of the routine work of the parochial surveyor, but of the various Acts of Parliament under which we work. There are no doubt a great many provisions of the Acts of Parliament appertaining to the Government of the metropolis, which could be amended to the advantage of the community if the experience of practical men were brought to bear on the subject. If at any time the legislature could have sufficient leisure to spare a little time from matters of imperial moment to matters affecting the health and comfort of the people, apart from glory and conquest, there would be a great deal of advantage accruing to the community. I have just marked a few points which struck me as Mr. Barber was reading his paper, but I have not had time to study it thoroughly, and therefore my remarks must be taken to be of a general character. The first point I would touch upon is the question of the drainage of existing houses, dealt with on page 67. Mr. Barber refers to the extensive powers conferred by section 73, first Act, with respect to drainage works and sanitary arrangements in existing houses, which he says are rendered inoperative by the words "sufficient drain." He suggests an alteration of the section, giving to the authorities power to put its provisions in force in all cases where houses are found not to be drained or fitted with sanitary appliances to their satisfaction. Well, of course a power of that kind, if exercised with very great discretion, would amount to a great public service, but we do not always find powers of that description exercised with the discretion which is advisable. I think the law as it now stands, as amended by the Public Health

Act, gives about as much power to the public officers as they ought to be entrusted with. Speaking of my own district, there must have been some hundreds of thousands of pounds spent by owners of property in reconstructing drains, and the powers of the existing law have been sufficient to call for that outlay. With regard to drainage, Mr. Barber is quite right in saying there is no express provision requiring that either plans or sections of the proposed works shall be submitted, and he says it is often impossible for an order to be made within the time required by section 76 of the first Act, viz., seven days; or the fifteen days specified in section 53 of the second Act. Although there is no express provision in the Act for plans, I dare say most metropolitan surveyors have very little difficulty in obtaining plans for drainage. There is not much difficulty in getting over that omission in the Act. The drains must be laid to the satisfaction of the surveyor, and if builders will not submit plans, then after they have laid about 20 feet you find fault with the drain, and make them take it up and relay it in a different line. After you have done that several times the builder sees the error of his ways and submits plans. Mr. Barber says the power to make bye-laws as to drains is by section 202, first Act, conferred on the London County Council; but no such bye-laws have yet been made by that body. Strictly speaking, the County Council have not made bye-laws if we speak of an underground drain, but they have taken a great deal of trouble to make bye-laws as to soil pipes and water-closets. Hearing that the County Council were drafting bye-laws as to drains, I called at the Council offices a month ago to ask if they would let the Secretary of this Association have a copy of the draft bye-laws as proposed, when we would discuss them, and arrive at a consensus of opinion respecting them. It struck me that would be a better plan than sending the draft round to the thirty or forty vestries in the metropolis, as they did the draft bye-laws for soil pipes and water-closets, and getting such a variety of opinion that nothing satisfactory resulted. We could then have considered them in this room as practical men who have to enforce the bye-laws after they are made. They told me they thought it an excellent suggestion on my part, and they would endeavour to meet it, but they were afraid from the state of the draft that it would not be sufficiently advanced in time for this meeting. In fact they were taking counsel's opinion on one or two points before they could settle the draft. We have not received the draft, and

therefore we shall have to go through it the same as the draft bye-laws for soil pipes and water-closets. There were some very queer provisions in the soil pipes draft bye-laws, as, for instance, the weight of iron pipes: I suppose some one in the office had gone to some text-book and taken out the weight of water mains. If those pipes had been insisted upon, they would have pulled down any jerry built house they were put against. On page 69 Mr. Barber refers to the paving of courts. There is no doubt that is a very difficult matter. In almost every parish in London there are a number of dirty little courts and passages which the authorities find great difficulty in dealing with. The trouble mainly arises from the difficulty of finding an owner of the court. If any one wished to build over them, or a railway was to come and want the land, an owner would soon turn up, but when it is a question of spending money the owner keeps in the background. I have in my own Vestry suggested the issuing of a circular to the other metropolitan vestries and district boards, suggesting that powers should be obtained to treat these courts under section 105 of the Act as new streets, but without taking them under jurisdiction. My Board have coincided with the view set forth in that circular. As to the breaking up of streets, much could be said about that. One of the worries which is manifestly shortening the surveyor's life, is the action of the gas and water companies in constantly breaking up the streets; I know it is bringing my grey hairs in sorrow to the grave. You no sooner retire from the making of a street, satisfied with a piece of good work, than you go next morning to find the street all broken up and like a hill of ants. Mr. Barber suggests that persons opening the roads should be required to keep in repair so much of the roads as may be affected by such openings for twelve months after the openings have been filled in. There is already power to charge for twelve months' maintenance of the trench; at any rate I know I frequently do it. If from the trenches being badly filled in the work has to be again done within the twelve months, I charge them a second time. Mr. Barber suggests that in the event of alterations in line or level of road, mains, pipes, &c., should be altered as required by local authority at expense of owners of such mains. Although my sympathies are dead against the companies, I cannot go quite so far as that; I think it would be asking too much of the gas or water companies to lower their pipes every time we lower the roads. One of my roads I thought it would

be well to take 18 inches off the incline to improve it, and I called upon the gas and water companies to lower their mains, but did not ask them to pay for the work ; I thought that would be unjust to the companies. The question raised on page 72 with regard to street improvements is a very important matter as affecting local authorities, but I do not quite agree that we have no further powers than are given in section 72 of the Act of 1862. Michael Angelo Taylor's Act, 57 George III., gives vestries and district boards very full powers, and an immense number of important improvements have been carried out under it. I have carried out improvements involving thousands of pounds, and never asked the sanction of the County Council. We ask the County Council for their sanction when we want them to contribute some proportion of the expense ; but if we are prepared to pay for the improvement ourselves, we go ahead under 57 George III. ; I do not know whether we are right or whether this paragraph in the paper is right. My reading of the law is that the Act has never been repealed, and that all the powers are existing so long as they are not inconsistent with the later Act. Anyway we work under it. I think Mr. Barber might look into the matter again, when probably his views might be modified. I should like to express my personal thanks to him for the care he has taken in compiling this paper, and I am sure so long as the Members of the Association will enter into their duties in the spirit which he has shown, our interests will be advanced. There is one other matter I should like to refer to before concluding my remarks. It does not come within the four corners of the paper, but as the paper deals with some suggested improvements in the local management of the metropolis, I may perhaps be permitted to say something on a cognate subject. At the present time there is a conference going on between the local authorities and the London County Council, as to what powers under any revised scheme of local government should be transferred from the central authority to the local authority, and a great many suggestions are being made in that conference by gentlemen more or less acquainted with the subject. One point I have had very steadfastly in view is the transfer of the administration of the Building Act from the central authority to the local authority. I think there is no better work which could be entrusted to the local authority, if they are to assume the powers of corporations, than that they should be entrusted with

the supervison of the erection of buildings in their district, to see that they are properly erected and properly drained. At present the administration of the Act is mixed up between the district and local surveyors in a most confusing way, causing much unnecessary trouble and expense. The present system is a chaotic way of supervising work which would not be tolerated in any private establishment. I am sure if the work was transferred to the local authority the income received in the shape of fees would almost pay for the surveyors' departments of the vestries of London. The opponents of my views hold that we are not competent to discharge this duty, and in many cases I admit that; but if the necessity arises for the man the man will be forthcoming. It would improve the status of the surveyor, and would be to the advantage of the community, as the result would be better buildings and cheaper buildings, because there would not be so many fees and salaries to be paid. This subject of the transfer of building supervision to the local authority, working under general bye-laws, with right of appeal to the County Council, will be brought before the conference before referred to, and I trust that my views will be carried.

Mr. Mason: Perhaps I may be permitted to say, in my opinion this is one of the most important papers we have had presented to us as metropolitan surveyors. I fully endorse everything that Mr. Weaver has said, and should like to comment on one or two points which have struck me in listening to the paper. First, as to the ventilation of main sewers, I agree with Mr. Barber that the obligation on vestries and district boards to ventilate and cleanse the sewers vested in them (sections 71 & 72 of 18 & 19 Vict. c. 120) should be extended to the London County Council as regards main sewers. One of the County Council's main sewers traverses the northern part of St. Martin's parish; this sewer has, I believe, no direct ventilation between Chelsea and Little Queen Street, a distance of about three miles, the only means of ventilation being by a few vertical shafts connecting with local sewers at a higher level. Therefore the local authorities are in many cases blamed for inefficient ventilation, their sewers practically acting as ventilation shafts for the main sewer, and any complaints received from inhabitants, or persons passing through the district, of inefficient ventilation is placed upon the local authority, which is very unfair. I am perhaps to blame for having wrongly interpreted section 71 of the first Act, by which Mr. Barber says the vestries and district

boards are compelled to trap gullies, including those discharging into the County Council's main sewers. I always thought the onus of trapping these gullies was upon the County Council. In my own district—which is a small one—I have main sewers running through, and the gullies of these main sewers are untrapped. We have repeated complaints from owners and others as to the emission of sewer gas from the gullies. In every case of complaint I refer them to the County Council, and I have not known of any complaint being referred back to the Vestry.

Mr. Blair: Have the County Council trapped them?

Mr. Mason: My friend, Mr. Blair, asks me if they have trapped them; I must say I do not know a case where they have done so. A point on which I feel very strongly is as to the provision of plans for private drainage. I am inclined to agree with Mr. Weaver that where plans are refused the best way is to object to everything that is being done; but this is a matter that should be clearly defined by the legislature, and it should be a *sine quâ non* that plans of all drainage should be submitted to the local authority, showing what is proposed. By possessing a plan we know exactly what we are reporting upon, and what we have to instruct the inspectors to specially watch. The question of regulations for private drainage is also a very important one. It is a question I have had to thresh out on more occasions than one with committees of the Vestry. I have been told that the regulations I have framed cannot be law, although adopted by the Vestry. My reply has always been that they can. By the Metropolis Management Act absolute power is given to the vestry or board to do what they are advised is right. Therefore, why not define the requirements in writing. I regret that so very valuable a paper should be limited as to discussion, and I would suggest that we have an adjourned meeting. I think it is such an important paper that two or three evenings spent on the discussion would be time exceedingly well spent.

Mr. W. Nisbet Blair: I should not have liked the opportunity to pass without having said something on this paper, because it is a subject which I have been obliged to work up recently, and therefore I am tolerably familiar with the clauses of these complicated Acts. I am obliged to say I am not prepared to discuss the paper to-night, because I have only been able to run through the paper hurriedly for a few minutes. Can you hold out any hope of our having an adjourned meeting to fully discuss the paper?

Mr. Norrington: There is a good deal to be said in favour of an adjournment. The paper has reference to Acts of Parliament, and one would like to scan it over with the local Acts before them.

The Chairman: I do not know whether it is possible to have an adjournment. It rests with this meeting to decide that question. The paper is so full of debatable matter that it is impossible fairly to consider it at one meeting like the present; time should be allowed for careful perusal.

It was decided to adjourn the further discussion of the paper for metropolitan Members to a subsequent meeting, but provincial Members were asked to take part in the discussion that night.

Mr. J. T. Eayrs: I did not come with the intention of saying anything on this paper, because it appears to me entirely a metropolitan matter. There are, however, some points in it which touch very closely on my provincial practice, and from what I can gather, the difficulties which you experience here are also experienced in the country. A great many of the provisions of the Metropolis Management Act coincide with the Public Health Act, and the several points which have been taken up follow very closely in the same relation as they are in the provinces. I might perhaps supplement what has been said as to the drainage of existing houses. There appears to be no provision in the Public Health Act to prevent any one altering drains after they are laid. You may see them properly and perfectly laid one week, and any one may go the next week and take up the drains and alter them in any manner he may think fit. I do not know whether the Metropolis Management Act deals with that; if it does not it ought to do so. Then with regard to plans of drainage, I notice nearly all the London vestries insist upon plans being submitted for drainage purposes. My own opinion is they cannot be enforced. Mr. Weaver says, put as many obstacles in the way of the builder as possible. If the owner is laying the drains properly, and is well advised in laying them, if you object to his drainage I do not see how the objection can be of value. He can go on and defy you, and make matters very awkward for the local authority. I think it should be made compulsory that plans should be submitted to a uniform scale and size. My own practice is to have a plan, and I am very pleased to say that every one in the district which I represent has fallen in very readily with that, and I have had no difficulty in getting them. The plans are on tracing linen of uniform size (foolscap) and we keep a full record of what goes on.

There is one difficulty I have sometimes: a man submits a plan for drainage which is right as far as it goes, but does not go far enough. If a man drains a certain portion of the premises you cannot compel him to go further provided there is no nuisance, but you express approval of it as far as it goes. Shortly afterwards he is called upon to do further drainage work, but he turns round and says they have been approved by the local authority. With regard to the paving and draining of courts, I can quite realise the difficulty of ever finding who is the freeholder or owner of the court. It is practically impossible to ascertain that without reference to the deeds of the property, which the owner would be very chary to show you. Where the owner lays out the land for building, he would not convey the roadway, he would simply convey the land for building, and the thoroughfare would simply vest in the original owner and no further notice is taken of it, and it does not become the property of any one. I can understand the difficulty of getting the owner of the adjoining property to prove that he is the owner of the court. There is one clause on page 71, with regard to projections, in which I am much interested. I have had considerable difficulty with regard to projections. People will put up signboards disfiguring the streets, and it is a matter we have no control over providing they are a certain height. You have to prove that the signboard is dangerous or an obstruction, which is difficult to prove if it is put up properly. There should be really some provision made whereby these projections can be regulated. With regard to private paving, I do not think it would be right where the authority calls upon the gas and water companies to lower their mains, to compel them to do so at their own cost. On that matter I agree with Mr. Weaver. I am sure we must all be very much obliged to Mr. Barber for preparing this paper. It is most instructive and very valuable to the metropolitan and also to the country Members. We shall be very much interested in seeing the result of the discussion. It may result in a committee of metropolitan surveyors to draw up the points in which the Metropolis Management Acts require amendment. There is no doubt the surveyors are the proper persons to realise all the difficulties, and if they were consulted more in the drawing of Acts of Parliament, we should get Acts which are workable, and the difficulties which at present crop up would not be so numerous.

Mr. Lewis Angell (Borough Engineer, West Ham), said: I am not a metropolitan Member, but I am very pleased to see

this large accession of metropolitan Members, which gives the Association not only greater strength but the advantage of other experience. We must congratulate Mr. Barber upon the manner in which he has dealt with a subject of very great importance. I am, although not in the metropolis, a next-door neighbour, and for some five years was a metropolitan surveyor, but as that is more than thirty years ago, the practice will have very much changed. We provincial surveyors have some advantage over our metropolitan colleagues, to the extent that we have the whole municipal engineering of the district in our own hands. The control is not divided among a great many bodies and officials as in London. I do not know that I can say much on the paper beyond what has already been said. If we have the power to adopt regulations as to drainage and sanitary fittings, we should also have the power to enforce them. As a rule people fall in with regulations, but we want powers to deal with those who will not accept them. Within the last fortnight I was in the courts, and one of the most able counsel of the day said we had no power to enforce regulations upon owners of property. Mr. Weaver has referred to the possibility of regulations being drawn up by the London County Council. I agree with him; it is very desirable that the regulations should apply to the whole of London, as the County Council would have power to enforce them; if different regulations are drawn up by the various vestries, it would be very difficult and confusing for builders. If the vestries are to enforce the regulations, they should be common to the whole of London. As to the obligations proposed to be placed upon the gas and water companies, I think you would find the companies are too powerful to submit to the regulations suggested, even if desirable, but you could not carry such proposals through Parliament. We have power under the Gas and Waterworks Act to require plans of mains and pipes which are laid. I have tried to enforce it, but the companies "bucked" very much; but we have that power, which I take it applies to London as well as to the provinces. I agree with Mr. Weaver that you could hardly expect the companies to pay for the lowering of water mains for carrying out street improvements. The subject of combined drainage has not been touched upon. The London County Council are trying to set that right as affecting the metropolis. Although there are points of difference between the metropolis and the provinces, the general

principle is the same, and I hope the London County Council will carry their Bill in Parliament, and the provinces will very soon follow their example.

Mr. J. T. Eayrs: With regard to Mr. Angell's remark as to plans for gas and water mains, I may say for the information of the country Members, that in West Bromwich we have plans and sections for every new water main laid in the district. I raised the question with the water company seven or eight years ago, when I saw that we could enforce it, and we have not been troubled since upon the matter.

Mr. Norrington: The question of the drainage of existing houses has always been a source of trouble to the London vestries. I have had to do with a great many troublesome cases. In some, the vestry has tried to enforce their regulations by appealing to a magistrate, sometimes successfully and at other times the reverse of successfully. There is considerable weakness in the present Act of Parliament on these matters. I agree with Mr. Barber as to the advisability of having plans deposited by builders, and I think plans should also be submitted for all reconstructions. My Vestry has had the same question raised about submitting plans, and has had them refused. With reference to the question of paving and draining courts, it is the custom of some London vestries to pave these courts and apportion the cost on the adjacent owners. That has been done very successfully in many cases I know of. Michael Angelo Taylor's Act is in force at the present time, and does remove some of the objections which Mr. Barber has raised to section 72. I have known that Act put in force recently. With reference to the supervision of buildings, undoubtedly the divided supervision in London is a very old sore. I referred to it some years ago in a report to my Vestry. It creates considerable extra trouble and difficulty, and should be altered. I hope the London surveyors will try to induce the members of the committee who are conferring with the London County Council to deal with this subject. The paper is a very valuable one, and opens a very wide field for discussion. I should like to go through it with the Acts of Parliament, and speak upon it on another occasion.

Mr. T. H. Yabbicom: With regard to provincial practice, in Bristol the gas and water companies work under dissimilar Acts of Parliament. The gas company is compelled to raise or lower its mains when required by the Corporation, but that is not the

case with the water company, where the cost of relaying the mains to suit any alteration in the level of the street has to be met by the Corporation. We find just as much trouble in provincial practice with the breaking up of the streets as you do in the metropolis. I have made an arrangement with the gas company which works very well, by which the Corporation reinstates every surface opening and keeps it in repair for twelve months at the expense of the company. The company, in addition to the statutory notice, sends a full list of openings which they have made; each opening is measured up, and the cost of the repairs is paid for at the scheduled price. I have not been able to succeed with the water company to the same extent, except that the relaying of wood paving is done by the Corporation and paid for by the company in the same way as for the gas company.

Mr. C. H. Lowe: There is not the slightest doubt that each page of this paper would give us an evening's employment to discuss. The points touched upon are so numerous and important that the adjournment of its consideration is very wise, so as to enable us to look through the paper with the Acts of Parliament referred to. With reference to sewer ventilation, I suppose no district has apparently suffered more from the effects of the outcry as to sewer air than Hampstead. With regard to plans for drainage, we have experienced no difficulty in obtaining the deposit of plans in the case of new drains. I do not think that difficulty need be anticipated at the present time by surveyors. If they insist upon plans they will succeed in getting them. The difficulty is chiefly in the case of reconstructions of old drains. A man reconstructs or alters his drains, and does not trouble about informing the local authority as to what he is about to do; and until one sees some evidence of work going on, it is impossible to know what is being done. The subject of projections over the footpath is often very troublesome in Hampstead. We have endeavoured to remove objectionable signboards or advertising boards projecting over the footpath, but found we were powerless unless we could prove they were an actual obstruction or annoyance to passers-by. Therefore you have practically no power to interfere, and these unsightly boards go on multiplying all over the district. The last matter I can touch upon this evening is in reference to street improvements. In my own district we have carried out five or six improvements under Michael Angelo Taylor's Act. But I should

advise any one not to rely too much upon this Act. The powers that be do not like it, and many times it has been termed an obsolete Act. It would be preferable to go to Parliament to obtain new powers rather than rely upon it. I am much obliged to those country Members who have made the journey here to give us the benefit of their experience, and their support and assistance in the discussion.

NOTES ON THE WEAR OF HARD WOOD PAVING, AND THE WEIGHT OF TRAFFIC THEREON.

By W. NISBET BLAIR, Assoc. M. Inst. C.E.

In order to ascertain the rate of wear on different pieces of wood paving, and to know the actual amount of traffic thereon, observations have been taken recently with regard to some roads in St. Pancras, and it is thought that the figures may prove of interest to Members of the Association. It is of little use to be informed by the writers of the many pamphlets which have appeared during the past few years, each referring to some particular class of Australian or New Zealand timber as suitable for road paving in this country, that such and such a timber would require to be renewed "not earlier than twenty-one years after being laid, and most probably not for fifty years under the heaviest traffic"; indeed, it would almost look as if the heavier the traffic the longer would be the life of the wood. Sometimes more precise statements are made, as, for instance, in referring to Queen Street, Sydney, it is stated that a daily traffic of approximately 25,000 tons passed for eight years over some wood paving which, when removed, showed that the gross wear observable was $\frac{1}{16}$ inch. In another street in Sydney, described as one of the busiest, the blocks were only reduced $\frac{5}{16}$ inch after thirteen years' wear.

A paper by Colonel Bell, United States Consul in Sydney, recommending the use of the Australian hard woods for use in American cities, quotes George Street, Sydney, where paving laid eleven years previously, showed less than $\frac{1}{2}$ inch wear in the centre; he does not say this was the maximum wear, but we may assume it to be so, nor does he name the wood employed; but he speaks of the street as "very narrow, only 48 feet between kerbs." The traffic is stated as amounting to 3324 vehicles in three hours. To give one some idea of what this is, it has been found that in Euston Road, opposite the Midland Station, 3051 vehicles passed in three hours.

Coming to observations made by some Members of the Associa-

tion, Mr. Mason, of St. Martin's Vestry, says that in the Strand, at the West Strand Post Office, yellow deal wore down $4\frac{1}{2}$ inches in twelve months. This was replaced by jarrah, which wore $2\frac{1}{4}$ inches in three years, or $\frac{3}{4}$ inch per annum. Then came a trial of karri, upon which the wear amounted to $\frac{1}{5}$ inch per annum. It should be observed that this situation does not give a fair example of the wear under normal conditions of traffic, for owing to its being a stopping place for omnibuses to the number of 300 to 400 per hour, the wear is excessive to the highest degree. In another part of the Strand, near Exeter Hall, deal lost $2\frac{1}{2}$ inches in four years, and jarrah 1 inch in the same time.

Mr. Norrington, of Lambeth, is quoted as stating that jarrah wore down $1\frac{1}{2}$ inches in six and a half years, or $\frac{1}{4}$ inch per annum, but no reference is made to the situation or the traffic. Perhaps he will be good enough to give the Association some further particulars.

It is, of course, generally admitted that the life of these hard woods must be considerably greater than that of other timbers used in the towns of this country before their introduction; but as to how much longer such life will extend we are still limited to speculation, for there has not been any hard wood pavement worn out in this country yet, and certainly some of those portions which have been longest laid look remarkably well and likely to go on for many years without becoming so irregular on the surface as to need relaying. In view of the probable long life of the hard wood as a paving material, it may seem rather early, so far as the cases to be quoted are concerned, that any figures as to wear should be submitted, but the information was only obtainable by the Author with regard to cases in the district under his control, and the statements are submitted to the Association to be taken at their worth, whether more or less.

Between February 23 and March 11, 1893, a portion of the western end of Euston Road was repaved, and, with the special object of proving the durability of the different timbers employed, the length in question was paved in four blocks. From the line of the south side of Southampton Street, a length of 63 feet was paved with jarrah, the next length of 63 feet was paved with yellow deal, the next length of 62 feet was paved with karri, and a closing length of 49 feet with yellow deal.

The wear upon these different lengths has been recently measured, and may be taken as at three years from the date of laying.

It proves to be $\frac{1}{4}$ inch on the jarrah, $\frac{1}{4}$ inch on the karri, and $1\frac{3}{8}$ inch on the deal blocks. These measurements were taken in the centre line of traffic, where the wear might be regarded as greatest, and at about the centre of each length of wood. It was found that the reduction in depth was the same on both sides of the road. These figures are equivalent to $\frac{1}{12}$ inch per annum on the jarrah and karri, and $\frac{11}{24}$ inch on the deal, and the relative rates of wear are as 1 to 6.

It should be mentioned that this portion of the road has electric lamps placed at intervals along the centre of the road, so causing a marked division in the lines of traffic passing eastward and westward. The whole width of the carriage-way from kerb to kerb is 33 feet 9 inches, of which 15 feet 3 inches forms the available width on the north side of the refuges upon which the electric lamps stand, and 14 feet 10 inches the width on the south side of the refuges, the refuges occupying 3 feet 8 inches.

A complete record of the traffic during seven days, including both night and day continuously, was taken between July 14 and 21, 1895. The observer was supplied with ruled books (see pattern leaf on next page), in which it was only necessary for him to make a dot or stroke in the particular column suited to the vehicle to be entered, and by ruling across the page at each hour of the day or night the number of each class of vehicle is obtainable for each hour. The numbers of the different classes of vehicle were afterwards multiplied by their weights, giving the total weight for each day.

The results showed that during the seven days, 110,977 tons of traffic, i.e. vehicles and their loads, not including horses, passed along this portion of the road ; this may be taken as equal to 5,770,800 tons per annum, or 575,544 tons per yard in width per annum. The omnibus traffic during the week amounted to 8575 tons, or 7·72 per cent. of the total traffic.

The first four days under observation were dry, and the last three days wet; but during the week the observations showed that no horses fell upon the length of road in question.

Observations both as to wear and traffic were also obtained upon another length of Euston Road, at St. Pancras Church. This portion of the road was paved with jarrah blocks between April 30 and May 24, 1894. The road has therefore been under traffic for say $1\frac{3}{4}$ years, and the wear has been very carefully measured upon an opportunity afforded by a water trench which completely

RECORD TABLE OF STREET TRAFFIC.

Name of Street..... *Class of Pavement*..... *State of Repair*.....

Width between Kerbs.....*ft*.....*ins.* *Gradient* 1 *in*..... *Period under observation from*

time and date *time and date*

.....*to*..... *Name of Observer*.....

Insert each hour and run line across page to show traffic from hour to hour.	Description of Vehicles.											Exceptional loads, weight to be inserted.	Horses Falling.	Condition of road at time of fall (wet, dry, greasy, sloppy).
	Omnibuses.			Heavy Dray.	Light Dray.	Heavy Van.	Light Van.	Tradesmen's Shop Vans.	Carriages and Cabs.	Loaded Carts.	Empty Carts.			
	Full.	¼ full.	Light.											
	65 cwt.	45 cwt.	35 cwt.	90 cwt.	40 cwt.	70 cwt.	35 cwt.	15 cwt.	15 cwt.	40 cwt.	18 cwt.			

crossed the road from kerb to kerb. The blocks were exactly 5 inches deep when laid, and the wear is shown upon the diagram. The greatest reduction being $\frac{5}{16}$ inch at 12 feet from the kerb on the south side, and $\frac{3}{16}$ at about the same distance from the north side. The greatest wear is therefore ·18 of an inch, or less than $\frac{1}{5}$ inch per annum.

The record of traffic taken near this trench, at a point where the road is 38 feet 4 inches wide, shows that during seven days from August 26 to September 2, 1895, 101,063 tons passed in the week, or 5,255,276 tons per annum, or 411,318 tons per yard in width per annum. The weight of omnibus traffic included in the above is 32,113 tons per week, which is equal to 31·8 per cent. of the total weight of traffic. The total number of vehicles during the week was 67,153, of which 12,677 were omnibuses, their proportion being 19·0 per cent. of the total number.

During the week under observation the road was described as in a greasy condition, with the result that seven horses fell.

The Author has referred to weight of omnibus traffic as distinct from the remainder, as he believes that the effect of omnibus traffic upon a roadway is very much greater than an equal weight of general traffic, and it remains to be seen whether the second instance described, with 31·8 per cent. of omnibus traffic, wears better or worse than the first case, where omnibus traffic is only 7·72 per cent., though the total traffic is about 40 per cent. greater in the first case than in the second.

It will be recognised by those who know London well, that the omnibus traffic of Euston Road is not nearly so great as in many other roads nearer the Thames, but it may be interesting by way of comparison to refer to figures contributed by Mr. Mason, of St. Martin's Vestry, who reports that the omnibus traffic in the Strand, by the West Strand Post Office, amounted to 402, 354, 378 and 306 omnibuses per hour. In Euston Road it is found that 258, 257, 247 and 237 omnibuses have passed per hour.

Tottenham Court Road was paved with jarrah blocks, between September 16 and December 12, 1892, and has unfortunately been opened by trenches for gas, water, or other purposes, only too many times, and the wear of the blocks has been noticed; but there does not appear to have been as much as $\frac{1}{4}$ inch wear anywhere, except against manhole covers or other surface-boxes. The traffic here has not been recorded as in the other cases quoted, but it is very considerable, probably more than in Euston Road.

Another road, of somewhat different character, has been under the author's observation, but more with regard to the effect of traffic than to actual measurement of the wear of the pavement, namely, Gray's Inn Road, because, owing to a double line of tramway passing along the road, the effect upon the paving has proved to be very prejudicial to the durability of the wood. This road was paved with jarrah blocks between the tram rails, and on strips of about 18 inches in width outside the rails, between May and September 1894. The portions of the road outside this limit were in some cases not interfered with, but in other cases were repaved with the old blocks, as the general condition was not sufficiently bad to necessitate reconstruction, and it was anticipated that three or four years' life remained in the blocks.

With regard to a road of this character, it is a question upon which the Author would be glad to hear expressions of opinion by Members of the Association, as to how the yard tonnage of the traffic should be calculated. It is quite clear that the bulk of the free traffic uses the sides of the roads clear of the tram rails, and yet it is equally clear that the effect of tram rails existing in a road induces many vehicles to run with their wheels on either or both sides on the tram rails or immediately adjoining thereto, with the very unfortunate result of forming a groove in the paving which quickly wears below the surface of the tram rail. It is, of course, not reasonable to add in the weight of tramcars with the other traffic upon a road; at the same time, it is not equitable to apportion the free traffic solely to the width of the road clear of the tram rails.

HARD WOOD PAVING.

By J. P. NORRINGTON, Assoc. M. Inst. C.E.

Having been asked to supplement Mr. Blair's paper with some observations, the Author begs to express his regret that the time at his disposal has not enabled him to give the matter the attention it deserves.

The parish of Lambeth probably has the largest area of any place in England paved with hard wood. This is due to the foresight of the Author's predecessor, Mr. Hugh Macintosh, who was, in the face of a strong opposition on the part of many members of his Vestry and others, probably the first surveyor to use these woods on a large scale.

The first piece of Australian hard woods was laid in May, 1889, when the portion of Westminster Bridge Road between the foot of Westminster Bridge and the junction of York Road was paved with jarrah.

A list of all the roads paved with hard wood in Lambeth is given on the following page.

The method adopted by the Vestry is to purchase the timber by the load, the price varying from 5*l.* 19*s.* to 6*l.* 2*s.* 6*d.* per load, which includes barging alongside the Vestry's wharf. It is then unloaded by the Vestry's men and sawn into blocks close to where delivered. It is customary to estimate that 640 blocks $4\frac{7}{8}$ in. in depth can be cut from one load, which brings the cost per 1000 blocks to 9*l.* 11*s.*, the cost of cutting being 4*s.* 9½*d.* per 1000. The loss in sawing is precisely $\frac{1}{8}$ in. per block. On testing this, 17 saw cuts were found to be equal to $2\frac{1}{8}$ in. The cutting is done with a single saw 30 in. diameter, which is worked by an 8 horse-power gas engine, the saw making 1200 revolutions per minute, and four saws require to be sharpened each day. The effect is to cut the blocks with great rapidity, 37 blocks being cut in 70 seconds, and 43 blocks in 78 seconds.

Most of the roads paved with wood in Lambeth are level; Waterloo Bridge Road, however, which is paved with jarrah, has a gradient of 1 in 35 from the entrance to Waterloo Station to the bridge over the Thames. This road has an enormous traffic.

Most of the Members will recollect the Author's paper of March 1893, in which the use of hard woods is recommended in preference to deal; the opinions therein expressed have been very much confirmed, the only variation is that the jarrah supplied to

Locality.	Area in sq. yds.	Date Laid.	Cost of Work.			Cost per yd. sup.		Remarks.
			£	s.	d.	s.	d.	
Westminster Bridge Road	1,960	1889	1,096	11	9	11	8½	New, replacing macadam.
Lambeth Walk	4,956	1889	3,095	6	1	12	6	Ditto.
Lower Marsh, &c., New Cut	8,723	1890	5,254	9	1	12	0½	Ditto.
Oakley Street	3,656	1890	2,216	9	0	12	1½	Ditto.
Brixton Road, Brixton Hill (part of), Kennington Park Road (part of)	31,175	1891–3	23,944	0	0	15	4¼*	Ditto.
Stamford Street	4,700	1892	2,623	8	3	11	2	Relay, replacing deal.
York Road	7,000	1893	3,952	5	7	11	3½	Ditto.
Brixton Hill (part of) ..	1,112	1893	798	19	10	14	4¼	New, replacing macadam.
Albert Embankment, Lambeth Road	5,474	1893	3,676	2	9	13	5½	Relay, replacing deal.
Westminster Bridge Road	7,010	1894	4,159	5	3½	11	10¼	New, replacing macadam.
Kennington Road	21,878	1894	14,084	4	6½	12	10½	Ditto.
Waterloo Road (part of) ..	1,014	1894	522	7	7	10	3½	Jarrah, stringy bark and blue gum, relay part and part new.
Upper Kennington Lane	10,352	1894	8,153	0	0	9	1	Relay, replacing deal.
Lower Kennington Lane	7,574	1895						
Waterloo Road	12,435	1895	6,512	2	1	10	6½	Part new and part relay.
Kennington Park Road ..	4,338	1895	4,280	18	0	12	11	New, replacing macadam.
Clapham Road	16,295	1895–6	15,665	12	6	13	4	Ditto.
Total	149,652							

* This includes cost of relaying footpaths, &c.

Lambeth Vestry is somewhat superior to the sample then experimented on and referred to.

In that paper the Author advised surveyors to obtain alternative tenders for karri or jarrah. His suggestions now are that, in addition to the Western Australian woods, numbers of other Australian woods, of more or less equal quality, provided, of course, that they can be supplied at reasonable prices, might be encouraged.

Below is a list of the names of some woods which appear suitable for wood paving:—

	Local Name.	Botanical Name.	Weight per cub. ft. in lbs.	Breaking Strain in lbs. per sq. in.	Elasticity in lbs. per sq. in.
West Australia	Karri	*Euc. Diversicolor* ..	65·00	215·00	7070·000
	Jarrah	*Euc. Marginata*	56·00	171·00	2940·000
New South Wales	Iron Bark ..	*Eucalyptus Cuba* ..	73·85	..	5526·400
	Blackbutt ..	„ *Pilularis* ..	66·69	..	3105·979
	Mahogany ..	„ *Resinifera*	75·06	..	3741·376
	Tallow Wood	„ *Microcarys*	72·06	..	2274·790

The figures given for karri, jarrah and iron bark are from T. Laslett's 'Timber and Timber Trees.'

The samples produced are as follows:—

Wood.	Locality.	Date laid.	Years' wear.	Loss.	Dec. of in. loss per. annum.
1. Jarrah ..	Westminster Bridge Road	May 1889	nearly 7	$1\frac{1}{8}$	·1607
2*a*. Karri ..	Crossing Lower Marsh, 6 feet from side	Nov. 1890	$5\frac{1}{2}$	$\frac{1}{4}$	·045
2*b*. „	Crossing Lower Marsh, centre	„	$5\frac{1}{2}$	$\frac{1}{16}$	·01126
2*c*. „	Crossing Lower Marsh, 6 feet from op. side ..	„	$5\frac{1}{2}$	$\frac{3}{16}$	·0337
2*d*. Jarrah ..	Lower Marsh, 6 feet from side	„	$5\frac{1}{2}$	$\frac{1}{4}$	·045
2*e*. „	Lower Marsh, centre ..	„	$5\frac{1}{2}$	$\frac{1}{4}$	·045
2*f*. „	Lower Marsh, 6 feet from op. side	„	$5\frac{1}{2}$	$\frac{1}{8}$	·02275
3. Blue Gum	Waterloo Road (beyond Station)	Oct. 1894	16 months	$\frac{1}{16}$	·047
4. Black Butt	Ditto	Sept. 1895	5 „	nil.	nil.
5. Stringy Bark	Ditto	Oct. 1894	16 „	$\frac{1}{16}$	·047
6. Jarrah ..	Lambeth Walk	Sept. 1889	$6\frac{1}{2}$	$\frac{3}{8}$	·05769
7. „ ..	Westminster Bridge Road	May 1889	nearly 7	$1\frac{1}{8}$	·1607
8. „ ..	Ditto	„	„ 7	$1\frac{1}{16}$	·15178

The traffic in the Westminster Bridge Road (towards Westminster) where these blocks were removed from, is at the rate of 334 tons per foot in width of road in twelve hours, from 6 a.m. to 6 p.m.

The traffic on the other side of the road from town is equal to 233 tons per foot in width of road.

The length of jarrah paved roads in Lambeth is about nine miles.

DISCUSSION.

Mr. C. Mason: Mr. Blair has done me the honour of quoting some statistics furnished by myself in a paper previously read to the Members of this Association. I therefore venture to trespass further upon your time by acceding to the chairman's request that I should open this discussion. There are one or two points in connection with Mr. Blair's paper, which require a little explanation in helping us to consider the relative wear of hard wood in relation to the traffic upon it. The diagram showing a cross section of Euston Road gives the wear in fractions of an inch, beginning with $\frac{1}{16}$ of an inch on the south side, increasing to $\frac{1}{4}$, then $\frac{5}{16}$, with $\frac{1}{8}$ in the centre, and $\frac{3}{16}$, $\frac{1}{8}$ and nil on the north side. I should like to ask Mr. Blair whether the traffic on the south side is greater than on the north side, or in other words, whether the traffic going west is greater than the traffic going east; for by the diagram the wear on the south side of the road appears to be double that on the north side. If the traffic on each side of the road is practically the same, these figures lead us to suppose there is something wrong with the paving material on the south side of the road. The figures given in my paper were for the average wear across the portion of the road paved with hard wood, $\frac{3}{4}$ inch being the average wear of the jarrah, compared with $\frac{1}{5}$ inch per annum for the karri. This may be taken as the ratio of the wear of the two woods according to my observation. Another point is as to the "caning" of the blocks.

Mr. Norrington: I said the caney nature of the wood.

Mr. Mason: I mean the bearing over of the blocks; had they been laid close together that would have been obviated. I have some interesting points as to laying blocks close together, compared with a $\frac{1}{4}$ or $\frac{3}{8}$-inch joint, on a considerable gradient. The importers of the wood came to me, saying I was making a great mistake in laying with a $\frac{3}{8}$-inch joint: the blocks ought to be laid with a close joint. I thought I would try whether the $\frac{3}{8}$-inch joint did answer better on a gradient, so I laid one portion with a close joint and another with a $\frac{3}{8}$-inch joint. I found, on examination after two or three years' wear, that the wear and tear on the close joint was practically as much as that on the open joint, if not a little more. Thus you see in the case of excessive wear on an incline there

is not much to choose between the close or the open joint. In my own opinion, with a fairly level road the close joint is by far the best, and I now always advise my Vestry to lay the wood with a close joint ; but on a gradient with heavy traffic there is not much to choose between them. In Mr. Blair's statistics nothing is said of the horse traffic, which is as important as the wheel traffic, and it would be interesting to have this worked out if possible. In narrow streets you can clearly see the line of the horse and wheel traffic, and it will be noticed in such places that the horse traffic wears the roads more than the wheel traffic. If some means could be devised for ascertaining the "hoof" traffic as well as the wheel traffic, and then reduce both to a standard of traffic, we should have a good basis to go upon in determining the relative wear and life of the various woods. As intimated in my reply to the discussion on my own paper three years ago, we have no data, no fixed rule, for taking traffic statistics. We give the number of horses, cabs, carriages, &c., and nothing else. If some combination could be formed whereby public authorities would join together and bear the expense of taking a long series of statistics, much valuable information could be obtained. Mr. Norrington in his remarks mentions Waterloo Bridge, and gives the gradient there as 1 in 35. I do not think he states the amount of wear on the wood.

Mr. Norrington: It has only just been done.

Mr. Mason: I should like to know whether he considers that gradient excessive or not. My opinion is that 1 in 35 is the maximum gradient for paving of this kind. We are sometimes inclined to run mad upon hard wood ; in my opinion it is possible to have it too hard. I have recently (in Coventry Street, Leicester Square) laid a wood which figures under three or four names, but is known really, I believe, as Moulmeim. A strip of this wood has been laid in front of the Prince of Wales Theatre, and is, in my opinion, too hard. Horses cannot get a foothold on it, and there are several other objections to it. My experience is that you can have too much of a good thing, and if we go on getting harder and harder wood we might as well put down cast iron at once. I will conclude by giving one or two statistics as to the expansion and contraction of hard wood. I laid some karri wood in Green Street, Leicester Square. Green Street has a width of carriage-way of 31 feet. I left 1½-inch expansion joint on each side of the street, and since then I have taken out two longitudinal blocks on each

side of the street, and in addition have cut off a quarter of the third block. That gives an expansion equal to about 1 in 40, proving that the hard woods do expand and contract equally, if not more so, than the soft woods.

Mr. T. H. Yabbicom : I am very much interested in these papers by Mr. Blair and Mr. Norrington, and desire to express my deep thanks to the metropolitan surveyors for the amount of information which they were good enough to give me when I was making inquiries some time ago for the Corporation of Bristol. The result of the information then obtained was that my Corporation decided to lay certain streets with hard wood. For the last three years we have been trying karri wood, and our experience, combined with that of the metropolitan districts, has been such that the Corporation has decided to extend its use, and I think very wisely, although I am not led away by the extravagant ideas which have been advanced, to the effect that hard wood will last such a very long time, say five or six times that of soft wood ; and in certain cases I think it will not be economical to lay hard wood, that is unless the traffic is such as to demand it. It has already been mentioned to-night, with reference to Tottenham Court Road, that the surface of a street is liable to be broken up a number of times from various causes, and this so damages the pavement that unless you have places where the ordinary soft wood would wear out in six or seven years, the extra cost is not warranted, and of course in provincial towns we have not the traffic you have in London. One place where I laid karri was on Bristol Bridge, the bridge over the River Avon on the direct line to the railway stations. This has been subject to heavy traffic for about twelve months ; a short piece lately taken up, showed that the wear during the twelve months has been about $\frac{1}{5}$ of an inch. As to laying the wood with the close or open joint, I am quite a convert to the close joint. The result is much more cleanly, and the wear does not produce that corduroy look and feel which a wood pavement laid with open joints gets, after several years' traffic ; the wear is always more on the joint than it is on the centre of the block. I especially notice this on the tramway tracks. We have a large amount of tramways, and whether it is caused by the fretting action of the horses' feet or not, but the corduroy appearance is more manifest there than on the sides of the road. Another difficulty with the tramways is the grooving at the side of the metals, and for that situation the hard wood is much more desirable than the soft. I was much surprised to hear Mr.

Mason mention the large amount of expansion with the Australian woods, as I have not found anything like that where karri has been laid ; 1 or 1½ inch is as much as I have allowed on each side of a street 60 feet wide, and these spaces have not disappeared yet. When the Bristol Corporation advertised some time ago for tenders for hard wood, it was stipulated that the people tendering should furnish sample blocks, and on weighing these blocks, say jarrah, the weight of 9 by 3 by 4-inch blocks varied as much as from 4 lbs. 3 ozs. to 3 lbs. 2 ozs. There were not two samples sent where the weight was the same. Those I should regard as the high-class woods weighed the heavier, and the lighter appeared to be submitted by people who were not in the habit of supplying a first-class wood, and probably got it at a cheaper rate. The blocks that were lighter in colour were also lighter in weight. I mention this, wishing to know whether the experience of London surveyors has been similar. The Corporation selected what I consider, although paying a higher price for it, was the best wood. Another block of hard wood was introduced to me as having been used by the engineers of the city of Worcester. It is a very ingenious built-up block, 9 by 3 by 4 inches, made of twelve rectangular pieces of oak, and is said to have the advantage of affording a good foothold for horses when laid upon a steeper gradient than 1 in 30. I induced my Corporation to allow me to experiment with a sample piece which I am going to put upon a gradient of 1 in 20, and if it interests any one, I shall be pleased to let them know the results.

The Chairman: We have had most interesting papers from Mr. Blair and Mr. Norrington on this subject. For myself, I have had very little experience with wood paving, but that experience agrees with Mr. Blair's. I have found a 4-inch expansion joint on a 60-feet road is quite sufficient and remains perfectly good. The modern system of skidding 'buses, on the soft woods more especially, is very injurious to the roads, as the skid is driven into the wood. The result is that we have shot holes very soon made in the new paving. The High Road, Kilburn, is paved for the most part with jarrah wood, and the gradient of 1 in 40 in a portion of its length is as steep a gradient as I should like to use jarrah wood blocks upon. I cannot agree with Mr. Mason as to the open joint or use of "screeds" between the wood blocks. I thought this practice had been discontinued for some time past, and that it was accepted that block to block was the only proper method of laying

wood paving. We may expect shortly to see the new electric motor carriages in the streets, when india-rubber tyres will be universal, and living in London a paradise. I am sure you will all join with me in thanking the authors for the interesting papers we have had on this subject.

Mr. W. Nisbet Blair, in replying to the discussion, said: I feel, Sir, my paper has been very successful. It has drawn from Mr. Norrington some very valuable figures, more than I was able to produce on my own account. It has also drawn from Mr. Mason his observation of the effect of expansion of hard woods. The paper itself is not really a subject for much discussion, and the only point upon which I wanted the expression of other opinions has not been touched by anybody—how we are to calculate traffic upon roads of complex character like Gray's Inn Road. It is not too late now if members who have observation of roads of this character will communicate their information to the secretary. I am glad Mr. Norrington has given us the figures of the Westminster Bridge Road. That was the road I had in my mind when I said some of the wood first used in London looks amongst the best. It certainly looks exceedingly well, though it was one of the earliest bits of wood paving in London. I agree with him as to some of the woods he has recommended as suitable for street traffic. Both blackbutt and tallow-wood promise to be good woods for paving, although I have not actually laid any. I am unable at present to answer Mr. Mason's question as to whether there is a difference in the weight of traffic between that passing westward and eastward on the Euston Road. I am afraid I shall not be able to do that, my records do not distinguish between the eastward and westward traffic, and without special observation I could not give him an answer; I should not, however, expect to find there is much difference. If I had made this diagram a little more complex by inserting double the number of figures, it would have appeared even more convincing than it is at present, for at 26 feet the wear was $\frac{1}{4}$ or $\frac{1}{16}$ inch different from the other side of the road. I am certainly surprised to hear from Mr. Mason that he finds no difference between wood laid with a $\frac{3}{8}$-inch joint and a close joint. I should certainly expect to find the paving laid with the wider joint wear quicker than the closer joint. We shall have considerable difficulty, I am afraid, if we intend to introduce the element of hoof traffic as distinct from wheel traffic on our roads. I think it is almost impossible to do it. You will see from the book I sent round the room, there is already a great amount of

trouble taken in classifying the traffic. You must have a man with an active eye and an intelligent mind to book all the traffic, because when you get something like 20,000 vehicles a day it keeps a man pretty busy. I quote from Mr. Boulnois when I say the standard is by yard per annum. That is the recognised standard not only in this country, but also as compared with Continental towns. I think that should be recognised and all figures brought to the same standard. As to the expansion of hard woods, I think there must have been something to account for the extraordinary expansion in Green Street in the condition of the wood when it was laid. I think the blocks should be laid directly they are imported. The instance Mr. Norrington has given, was of a stringy bark block which shrunk about $\frac{3}{4}$ inch in 3 inches and 1 inch in 9 inches. Strange to say that particular wood does not show any difference of expansion or contraction from the jarrah. We have one portion of a road laid with jarrah, with a lath between and a bituminous joint; the next length with stringy bark; and the next with blue-gum. Although they have shown such contraction in testing, yet in the road they do not show any such eccentricities. Proof in a few years will be obtained as to their relative wear. As to expansion, a great deal depends upon the age at which the wood is laid, and a great deal upon the manner in which it is laid. With cement-jointed paving laid in the Euston Road we left a 3-inch expansion joint, and in a few days, before we admitted traffic, that had closed up, and one course of blocks was withdrawn. The ultimate expansion of that wood was 4 or $4\frac{1}{2}$ inches on each side. But where laid with the bitumen grout there has not been any expansion. With regard to Mr. Yabbicom's remarks as to the weight of the blocks, I have found the same variation in the weight of these hard wood blocks. I think it is all due to the age of the wood and the extent of seasoning. If you want to compare on the same basis different classes of wood, the only way is to reduce them to the same extent of dryness. Keep them for some weeks in the same atmosphere, and having measured them, place them in water for seven days, and then you get the proper expansion. To take them approximately is of very little value. Mr. Yabbicom also mentioned the built-up block which is used at Worcester. It may be ingenious, but I do not think it will give good practical results. I have had a block submitted to me which seems to be formed of a combination of wood and asphalt. In this case the dovetails are of asphalt. What the advantage of that

will be I don't quite see. If you want an asphalt road make it asphalt; if you want a road of wood make it of wood; but I do not see the good of mixing it. As to skids, we are not as much troubled with skids as in some provincial towns. In the northern part of my district skids are used, and I had one cut in a road with a skid which was distinctly an eyesore at first, but it was obliterated after about two years' traffic.

Mr. J. P. Norrington, in reply, said: I was rather astounded at the figures relating to the expansion of wood paving given by Mr. Mason. I cannot say I have found hard wood to expand to that extent; of course, after a continued heavy rain it is necessary to send round the parish to examine the open joints left between the wood paving and the kerb to allow for expansion. Recently I have been putting clay instead of sand in this open joint, as it yields more freely under pressure. As to the difference of weights, I have found jarrah wood to vary very much in weight. The first paper I read on wood paving was after an experience of some light jarrah blocks. Since then my experience has caused me to look with suspicion upon light jarrah blocks. The light weight shows the wood to be lacking in closeness of grain, density, &c. Mr. Mason referred to certain woods as likely to prove too hard. I think that may prove true of iron bark. I had a conversation with a gentleman a little while back, who stated that he had tried to work iron bark, and that it destroyed his tools. I question whether the Australians will be able to cut it and send it over here at reasonable prices. Mr. Lowe has spoken of the effect on pavements of wheels skidding. I think a fair example of this effect is to be seen in front of the West Strand Post Office. The greatest injury appears to me to be done by the narrow wheels and heavy weight of the omnibuses. The condition of these hard woods at stopping places for omnibuses is a very severe test of their qualities. I was surprised to hear Mr. Mason say he found the pavements laid with wider joints between the blocks wear as long as the pavement with the close joint. I have been converted to the opinion that the close joint makes the best pavement. Unfortunately my Vestry do not care for me to lay paving with a close joint, and they prefer to use a cement grouting instead of pitch, such as I used at Fulham. I do not agree with Mr. Blair as to the non-seasoning of the wood. I hope that those who import the woods will take great care to season it. I believe that if it is seasoned there will not be the expansion and contraction in the pavements when laid which takes

place with new wood. We have all probably seen some wood paving in London which was laid in time of frost, and the joints of which opened to such an extent that it had to be relaid. My experience is that new wood when laid expands and contracts for a time, and (after it is seasoned) finally settles down to an almost stationary position.

Mr. NISBET BLAIR: One word in explanation as to the seasoning of wood. I mean to represent that wood should be laid very soon after it is imported into this country. I do not wish it to be implied that the wood should be felled when the sap is up, or sent out with the sap in it. Let it be felled at the proper time and cut up into deals, but the sooner it can be used after it is imported into this country the better it will be as a paving material.

The Chairman moved a vote of thanks to the Council of the Institution of Civil Engineers for allowing the use of the rooms for the meeting, which was heartily accorded.

The meeting then adjourned.

ADJOURNED DISTRICT MEETING AT WESTMINSTER.

March 11, 1896.

Held at the Town Hall, Westminster.

C. H. Lowe, M. Inst. C.E., Vice-President, *in the Chair.*

The discussion on Mr. J. P. Barber's paper was further proceeded with.

DISCUSSION.

Mr. W. Nisbet Blair: I feel a very great interest in this paper, and as I had not the opportunity at the last meeting of really saying anything, after consideration, and as I thought other people would be in the same position, I suggested that we should have an adjourned meeting. I have made some marginal notes which I will take in the order followed by the paper. The first note I have made is, that Mr. Barber should recognise the principal Act as the Act of 1855 and not 1856. That is purely clerical. My next note is against the first paragraph of the second page of the paper, under the head of sewers, "before any person can begin to construct a sewer a plan and section thereof must be submitted to the vestry and district board, and their consent in writing obtained to the proposed work." Neglect on the part of owners of property to comply with this direction has resulted in a great deal of the trouble in which local authorities are now placed with respect to the distinction between

sewers and drains, and the confusion is further increased by the interpretation of those words. That point has been the subject of communications to the Association before, and I do not intend to touch upon it further than to point out that if it had been made an obligation on private owners in laying out an estate to submit plans of the proposed sewers, then the Vestry and the Metropolitan Board —now the County Council—would have been in possession of information which would have enabled them to keep an eye upon the maintenance of these private sewers upon private ground. Now local authorities are spending enormous sums of money in relaying purely private drains on private property. In my own district we are just completing one little block which is costing us 1900*l.* That is due to the fact that the people who built the property built the sewers on private land without authority. We are hoping great things from the amending Act which the Council has promoted, which is framed on the lines of the proposals of the conference held in London twelve months ago. They have adopted the precise wording which that conference suggested. Mr. Barber suggests "that the construction of such sewers should be under the control and supervision of the surveyors, and that the cost of such supervision should be paid by the persons at whose expense the sewers are constructed." I agree with him in principle, and the statutes agree with the proposal, because where private work is executed by the local authority, that authority is authorised to charge 5 per cent. in respect to what amounts to supervision. To make a definite recommendation I would suggest that any amendment should embody the figure of 5 per cent. as the amount to be paid to any local authority in respect of any work to be executed. If any record had to be kept of the work of supervision it would render a great deal of book-keeping necessary, and would be much better avoided by the payment of 5 per cent. upon the cost by persons who may execute such work. With the next paragraph, in which Mr. Barber refers to the ventilation of sewers vested in the Council being specially provided for, I distinctly agree, and would emphasise the necessity of some such provision by referring to what has happened in my own district somewhat recently. The Council's sewer passing through the district receives our local sewers, and into one of them, a very short distance from the main sewer, the effluent is discharged from the gasworks. That effluent is at times strongly impregnated with ammoniacal liquors and

sulphur compounds, which give off most offensive smells all the way along the line of the Council's sewer. Complaints were made by members of the public, and on examination being made it was found that the offensive smells came from the Council's sewers, when the attention of the Council was called to the matter. The Council referred it back to the Vestry on the ground that the effluent was discharged first into one of the Vestry's sewers. We had to recognise that was correct. But when we attempted to deal with the gas company we found ourselves in a difficulty. Until the Act of 1894 there was no power authorising the local authority to take proceedings against any person discharging offensive matters into the sewers. In the Act of 1894 a clause is inserted giving the Council power to prevent the discharge of offensive effluents, not only into the Council's sewers but into local sewers discharging into the Council's sewers. It does not authorise the local authority to take proceedings, and in the case in question the local authority were unable, and the Council declined, to take proceedings. Therefore, except by calling the attention of the gas company to the offence, we are unable to do anything in the matter. Of course the offence was reduced in degree after the complaint, but we are unable to take any effective steps to prevent what is a nuisance. The matter has been known to the officers of the Vestry for thirty years, the difficulty being really to get such evidence that you might with any hope of success take proceedings against the company. We took samples of the liquid, had it analysed, and it was proved that the nature of the effluent was such as to cause the nuisance. In spite of our offer to support them the Council declined to take proceedings. We are helpless, and the Council by their inaction allow the offence to be repeated as often as the gas company care to permit it. As to gullies, Mr. Barber says "By section 71, first Act, the Vestries and District Boards are compelled to trap gullies, including those discharging into the County Council's main sewers, although by section 27, second Act, the last-mentioned gullies cannot be trapped without the consent of the Council or of their engineer." I do not think Mr. Barber has read the section of the first Act as closely as he might, or he might get a different result. The first Act forbids the ventilation of gullies by street gratings, whether by manholes or in the middle of the road. Mr. Barber then quotes the second Act, that gullies cannot be trapped without the consent of the

Council. There is certainly great confusion there. With regard to gullies I think they should be disconnected from the sewers into which they discharge. Gullies are incidental to the street formation. If there were no street you would need no gullies, and I think all gullies should vest in the authority in whom the street may be vested. In most cases the streets are vested in the vestry, even in cases where the Council construct, as in Rosebery Avenue; they hand the street over to the vestry to maintain. Therefore any power with regard to gullies should vest in the local authority. On the question of the drainage of existing houses, the words "sufficient drainage" are emphasised. Mr. Barber takes those words to be applicable only to the size of the drain. I cannot quite agree with him there, because the section refers to materials, size, level and fall of the drain, and I think that is all-embracing. The drain must be "sufficient" in all those respects. I think that gives us all we need. The weakest point in regard to house drainage is the absence of authority to require a plan. The plan is the most important thing, so as to record the work that is done, but at present we have no power to require it. In the case of the drainage of new houses the omission there is to provide a penalty for the offence. "It shall not be lawful" implies an offence against the statute which is not difficult to prove, but having proved that, we are at present in the position of having no penalty attached to the offence. Mr. Barber says, "drainage into cesspools, which is permitted by this section, should be prohibited." Yes, where a sewer exists within 200 feet of the premises, but there may be cases where no sewers exist within that statutory limit of 200 feet. In such cases we are bound to admit drainage into cesspools, and the liquid can be used on the fields and gardens, and the solids removed periodically. The alternative to extend the public sewer a long distance might be unreasonable in view of the size of the property to be drained. On page 68 is emphasised the necessity for plans. We have a case under notice at present where that is demonstrated most forcibly. A certain builder is redraining some property. He expresses his full desire and intention to comply with the wishes of the Vestry, but refuses to submit any plan. Therefore we do not know on what line he is going to relay the drain, and he refuses to inform us. He exposes himself to the risk of a double expense in doing the work wrong and having to amend it, but he refuses to recognise the assistance it would be to

the Vestry and its officers to have a plan first. I agree with Mr. Barber that direct authority should be provided for the vestries to make the regulations which are referred to in section 83. It is only by implication we can say we have authority to make regulations. Most local authorities have made regulations, and the Vestry of Islington has recently made some extended and elaborate regulations. The power to make bye-laws as to drains is, by section 202, first Act, conferred on the London County Council. The Council are now engaged in preparing new bye-laws from which we hope great things, though we have not yet any knowledge of them. I agree with the third paragraph, that sections 76 and 83 appear to recognise the power of the vestry or district board to make orders and give directions only in respect to new drainage and sanitary works, and it is doubtful whether they can exercise similar powers with regard to the reconstruction of drains. I maintain the laying of a new drain does not depend upon its dimension or length or size, but whether there was a drain there before, or whether it is to be reconstructed in a new position or at a different level or depth, even if it is only two pipes in length. Such a case I should maintain was making a new drain. On page 69 Mr. Barber says, "The Author does not consider that these regulations should be drawn up by the County Council, as that body has no experience in the carrying out of regulations relating to this subject. A committee formed of surveyors to metropolitan local authorities would be, in the Author's opinion, better able to produce a satisfactory and efficient set of regulations." I am afraid he is not likely to induce the Council to transfer any of their authority in the matter to the vestries. I am also afraid we should not convince the medical officers of health and the sanitary inspectors that we could produce an efficient code of regulations without their assistance. As to the power of local authorities to make private drains under the roads, and to recover the expense from the owner, it is legal to do so, but in my opinion it is not desirable. The local authority should throw the whole responsibility upon the owner or builder. Where any difficulty arises in any portion of the work, the idea is to throw the responsibility upon the local authority; but if the owner carries out the work no such difficulty can arise. As to the paving of courts, the principal difficulty is to prove who is the owner of the court, because the Act refers to the court and not to the property fronting the court. The houses may be held under lease, and for all statutory

obligations the lessee is owner of the property ; but I think it is doubtful if he is the owner of the court. I think there is no doubt in all the leases, or at any rate in nine-tenths of the leases, there is nothing to indicate that the owners of the houses own any part of the court. Therefore the liability in respect of paving the court is upon the ground landlord. I think that should be altered to bring it into a parallel position with work that may be executed under section 150 of the Public Health Act, 1875, where work in any road, street, square, court, alley or passage—there is a very long list which practically means everything that is not a public street—may be dealt with, that is, formed or drained by the local authority, and the cost of the work apportioned upon the property facing that work. Similar powers in the metropolis would remove the difficulty that now exists. The penalty that can be imposed under the Metropolitan Acts is too paltry to induce owners to comply with the regulations. It simply amounts to the payment of 5*l*. The law says that "any person who fails to comply with an order to pave a court is liable to a penalty of 5*l*." That leaves the responsibility upon the local authority to do the work. Mr. Barber says that clause 105 as to the making of new streets wants amending. Amended powers ought to be given to local authorities to make portions of a street, those portions being selected longitudinally or transversely. You may want to lay out a street where it is desirable to form and pave one side, because property is built on that side; but it may be undesirable at the time to lay out money in paving the footway on the other side of the street. Under the present powers you cannot do that. If you serve notices on the one side, you cannot recover afterwards for the other portion of the work. I know that in the provinces certain towns have the power to do the work in that way. There is also power to charge land less than buildings in laying out and forming roads, but there is nothing to provide that when that land is built on the owner shall pay the difference between the original payment and the actual cost of the work. It saddles the rates with a charge which the owner will have made as profit by deferring the building on his land for a few years. Then as to the powers of statutory companies to break up the streets. I am afraid we should not be able to secure the agreement of companies to the stringent conditions which Mr. Barber suggests, and in some instances it would be hardly practicable. We know in how many instances where openings are made they are matters of

emergency; it may be a burst pipe or something of that sort. In such a case would Mr. Barber require them to submit plans to the local authority before the work could be done? There is an important matter in connection with this class of work which I wish to call attention to. We have ourselves been landed in a very remarkable position in this way. Some three years ago, during the night—the exact time was about two o'clock in the morning—a portion of Euston Road between King's Cross and St. Pancras was observed by a watchman to be rising up before his eyes, and eventually he was confirmed in his idea when a terrific crack, almost like an explosion, took place, and then the whole place was deluged by water. Presently the water company's officer came and shut off the water, which did not do much damage to property but very serious damage to the road. It proved to be due to the fracture of a branch pipe from the company's main supplying the Great Northern Railway. It was such a connection as the water company was not authorised to lay, and the Great Northern Railway had no statutory right to require the water company to lay such a pipe. It was laid by agreement more than twenty years ago. It was not quite clear, but was supposed to be laid by the New River Company at the expense of the Great Northern Railway. The water company repaired the pipe and asked the Vestry's officers to repair the roadway. The granite roadway was undermined for a considerable distance, the concrete in many places lying hollow. Eventually we reached the limit of the disturbance, and made the repairs, which amounted to 250*l.*, the water company's charges for the repairs to the pipe being only 12*l.* In due time we charged the account to the New River Company; they returned it and asked us to send it to the Great Northern Railway. Their officers came to see me and discussed it, and I had every reason to suppose they would pay it. A delay occurred and we wrote to the railway company, who then returned the account, saying they were advised there was no liability resting on them. We then approached the New River Company, but they said it was not their pipe and they were not liable. We then consulted our solicitors, and counsel's opinion was taken, and we were advised that we should not be able to recover from the one or the other. The service pipe of 5 inches was one which the railway company were not authorised to possess, or the New River Company to lay under the road. I suppose the Vestry at the time thought it was the right thing to permit, though no

agreement was required. The result is we fell between two stools, and had to repair the road at our own expense. A similar case has occurred since this happened, and was reported about six weeks ago—Saint Olave's District Board against the water company on that side of the river—and the decision was that the Vestry could not recover the cost. Such a thing should be provided for. That is the most important omission in this paragraph relating to statutory companies' trenches. Mr. Barber deals with the question of street improvements, I think he has overlooked the authority which does exist under George III. chap. 59. That certainly does authorise the local authority to obtain property compulsorily for improvements. The method is somewhat cumbersome, because it provides that failing agreement there is to be summoned a sheriff's jury of not less than 48 or more than 72 to assess the value. We can understand the sort of judgment that might be arrived at by a sheriff's jury as to the value of property. But even that Act is open to question as to its powers, the question being whether that section gives the vestry powers as against a railway company which has obtained land under an Act of Parliament. I should argue it is so, although a railway company in my district say their Act overrides this antiquated Act, and does not allow their property to be taken from them even if a very heavy cost is paid for it.

Mr. Lovegrove said: There are several points in the paper to which I should like to refer. To one who has been accustomed to work in provincial towns it is very difficult to understand how, under the present divided state of things, municipal work is carried on in London. Take for instance the erection of new buildings, the supervision of the building itself is in the hands of one authority, and the supervision of the drainage in the hands of another authority. In the provinces the whole of the work is under one authority, and the inspection of the erection of buildings and the laying of drains is combined. With regard to the drainage of existing houses, I think that there will be some difficulty in obtaining regulations for the reconstruction of the drains. Most of these cases arise from three or four causes. (1) The existence of a nuisance; (2) Consequent upon an inspection of the drains after a case of zymotic disease; (3) As the result of house to house inspection; (4) A case of voluntary reconstruction on the part of the owner. With regard to the first three cases, the power of the local authority is to cause the defects which exist to be remedied. In the fourth

case, that of voluntary reconstruction, I take it that if the owner is willing to reconstruct his drains he is also desirous of putting them in the best condition possible. It appears to me improbable, however desirable it may seem, that you will obtain in London greater powers than those now existing in the provincial towns, viz. the remedying of defects which constitute a nuisance. In Hornsey we have a number of cases of defective drainage in hand, and in every instance a plan is kept of the drains. We have no such regulations as are suggested in the paper, but persuade the owners to see that what is asked is for their benefit, and we are able to get many things done, not only in the case of reconstruction of drainage but also in respect to the drainage of new buildings, which the byelaws do not provide for. This may be partly due to a local interest in sanitary matters, an interest that centres in the Sanitary Museum which my predecessor, Mr. Meade, laboured so hard and successfully to obtain. With regard to the opening of roads, Mr. Barber suggests that persons opening trenches should keep them in repair for twelve months. Judging from the number we have, I think that the maintenance of our highways would on these lines gradually fall into the hands of the various companies and others opening the trenches. The Waterworks Act, 1847, already requires that the undertakers opening the trenches shall keep them in repair for three months, or such time not exceeding twelve months during which the soil subsides, and it appears to me that it would be better that a schedule of payments should be adopted sufficient to cover the repair and maintenance of the trenches; but that in any case the actual work of repair and maintenance should remain in the hands of the local authority. Mr. Barber has already been deservedly complimented upon his paper, which deals with a subject of unusual importance, and I hope that his work will be rewarded by practical results.

Mr. P. Dodd: With regard to drainage into cesspools, Mr. Barber suggests that this should be prohibited. I should like to know what he would recommend should be done in the case of properties already having cesspools, and which are several hundred feet away from the sewers, and which cannot be drained into the sewers without considerable expense to the local authorities, seeing that they have no power to compel the drainage of any house into a sewer which is more than 100 feet distant therefrom. I quite agree there should be some further legislation upon this matter, as under the Public Health (London) Act, 1891, it is the duty

of every sanitary authority to empty and cleanse cesspools, privies, &c., and it is a question worth consideration as to whether it would not be more economical in some cases to lay the sewer up to 100 feet from the premises, and thereby save the continued expense of emptying the cesspools, &c. Another point of interest is one which I believe was referred to by Mr. Blair, viz, the paving of portions of a street. I have had a case before a magistrate to-day bearing upon this matter. The road in question is an old highway, and was for many years built on on the west side only, and the footpath on that side was kerbed and paved at the expense of the local authority in 1879. Recently seven or eight houses have been erected on the east side of the road, and it is now proposed to kerb and pave the footpath on this side, and apportion the cost on the owners on both sides of the road opposite the proposed paving. Some of the owners on the west side objected to pay their portion of the cost, first on the ground that it was an old highway, and secondly because their side of the road had been paved at the expense of the local authority. The case was partly heard to-day and was adjourned.*

Mr. Wheeler: There are several matters beyond even those which Mr. Barber has referred to, which I should like a committee of London surveyors to go through and see if we could not get them amended. Take the sewers for instance. I have large works in this parish which have been waiting a month for the consent of the County Council. Then when they give us power to do the work, they require us to surround the sewer with concrete because the pressure of water from their main sewer is so great that they are afraid these branch sewers will burst. Mr. Barber thinks, as the future maintenance of such sewers devolves upon the vestries and district boards, they should have power to require them to be constructed in accordance with specifications and detailed drawings of the sewers, manholes, gullies, &c., prepared by their surveyors; also that the construction of such sewers should be under the control and supervision of the surveyors, and that the cost of such supervision should be paid by the persons at whose expense the sewers are constructed. I would even go further than that. I should like to see these plans prepared by the surveyors, and the proportion of the cost of the drawings paid by the constructors of the sewers. Further than that, I think the whole of

* Since the date of this meeting the case has been decided in favour of the local authority.

the drainage of the houses should be under the supervision of the local authority, and that the authority should give a certificate so that owners of property should be in a position to say, "we have a certificate to show that the drainage is satisfactory." There ought also to be an inspection of house drains every three or four years. That is a work which the local authority has hitherto shirked. Under the present system, one portion of the work is under the local surveyor and the other portion is under the district surveyor. With regard to the ventilation of the sewers, it is a fact that in the Westminster district they object to ventilating shafts, and to our gullies, which we have to run on to the foreshore of the Thames. That is a wrong thing. I have fought the County Council because their system is not perfect, and they ask us to carry out a perfect system. Then as to the drainage of existing houses. We have a great many experts in this district, and they come before my committee to prove that their drains are efficient. We have no cesspools, as the sewers are near enough to the houses to compel the owners to drain into them. I do not have very much difficulty as to plans. We generally make so far as we can a survey of the drains ourselves, and we keep a record in that way. It is a difficult thing to do, but I keep in touch both by the sanitary inspectors and my own staff. As to drains under roads, I have not experienced any difficulty in this district with respect to that. If a man makes a complaint and suggests that the stoppage is in the Vestry's sewer, we require him to deposit a sum of money to cover the cost of the work. If the stoppage is in the Vestry's sewer the money is repaid, if it is in the owner's drains the cost of the work is charged. There have been only two cases where the stoppage was in the sewer. We have also met the difficulty as to the paving of courts. We have served notices under the Sanitary Act calling them insanitary courts, and deal with them as a nuisance. As to the making up of new streets, we have not had many in this district. In an adjoining district I had some experience of new streets, and we always included the cost of the gullies in the cost of the road, and so put it into the apportionment. I do not know of many cases where we had to sue after the road was made up. The suggestions in the paper are of very great value, and I think it is only right that a committee of surveyors should be appointed to work with Mr. Barber and to bring up a report on the different sections of the Acts. That is the only way to get the opinions of metropolitan surveyors.

The CHAIRMAN: I am sure, although our meeting is small in number, the interest in the paper has been very fully shown by the remarks of the speakers who have taken part in the discussion. I have looked through the paper carefully and have made a few notes upon some of the points. With regard to sewers, I think there must be some central authority to have control over the main sewers of the metropolis, and no exception could be taken to the local sewers being designed and constructed by the local authority. The question of combined drainage has been threshed out by this Association and by most of the vestries and district boards, and we have all felt the difficulty more or less. In my own district it has been less felt, because, fortunately, my predecessor covered himself by making special reports in all cases of combined drainage, and we can look up these reports and trace the statutory order required. The ventilation of sewers has caused a great amount of difficulty, largely due to sentiment. The sentimental complaint is one which is most difficult to deal with. I could give you an instance where the nuisance was thought to be so bad that I blocked up the ventilators as the most drastic remedy for the evil, but strangely enough the complaints came in just as frequent as before, thus giving a strong proof that a person seeing the ventilator in the street considers it to be a nuisance. Our difficulties are thus increased by the sentiment imported into it. Ventilators in the streets are doubtless a crude method of ventilating sewers, but we are advised they are the best system at present known. With regard to the drainage of existing houses, the byelaws recently passed are not retrospective in their nature; and where you have a good house drain which is doing its work well, but which may not be water-tight outside the premises, you cannot compel it to be brought up to stand the water or the smoke test. As long as the drain is doing good work I do not consider you can make the byelaws applicable in a retrospective sense. There have been two cases recently decided in the law courts, clearing the ground for us in regard to this. I happen to be a governor of a metropolitan school, and the Inspector recently called upon us to take up the old drains and put in an entire new system. The main drains were all situate outside in the playground, and 4 feet from the surface, perfectly good as drains, but not equal to stand the smoke or water test. The Medical Officer of Health very wisely said the drains were doing good work and were not likely to cause a nuisance, and he therefore could not press the matter. The result was that a consider-

able saving was effected. With regard to the drainage of new houses, we have to guard against over-sanitation. We have experts and experts. The builder possessing a truck containing six drain pipes, and a boy to push it, puts himself down as a sanitary engineer. Some drains are so trapped and over-trapped that the wonder is that any sewage finds its way to the sewers. You have to exercise care to prevent a householder being poisoned by over-sanitation of his own house. I have experienced no difficulty in obtaining plans. We have only had one case of refusal point blank to produce a plan. I think the public are now sufficiently educated in sanitary matters to put their houses in proper order. As to new legislation, there should be some general law under which we could act, and allowing local authorities to frame bye-laws, subject to proper approval, for their own districts. As to drains under roads, in my district (Hampstead) the builders make the sewers under my supervision, and we have had no difficulty. As to the paving and draining of private courts, there should be some powers to enforce, as in the case of new streets, apportioning the cost upon the owners. As regards any court which may be a nuisance, you have no difficulty under the Sanitary Act of 1891 in compelling the owner or owners to put it into good condition, so as to remove the nuisance. Like Mr. Wheeler, I have always charged the cost of gullies and works incidental thereto in any new street, in the apportionment, and have had no difficulty in recovering the money. I am afraid the question of breaking up of streets is too important a subject to go into to-night, a subject almost worthy of a paper to itself. We have experienced much difficulty with public companies, and now, with the electric light and other disturbances, the streets are ploughed up in all directions, and we have no chance of supervising as rapidly as we ought. The alteration of levels of paving is provided for. There is a provision in the Metropolis Management Act giving the vestries the powers to raise or lower the level of a roadway. I do not say you have the right to raise without compensation the roadway, say 5 feet, so as to bury a man's doorway, although the Act is perfectly silent on this subject. It simply says "they shall have power to alter the roads." As to projections, notice boards, &c., Mr. Barber says they are becoming a nuisance in London, and we have not much power to deal with them. The Hampstead vestry have tried to deal with signboards, but without much success. But an even greater nuisance is the "squatter" on the footpaths, the vendors of flowers, gold-fish, toy balloons and other things, people

who pay no rates and undersell the tradesmen. The police, unlike the "good Samaritan," pass by on the other side and do nothing. If you attempt to remove them, strong representations are made to you by benevolent people to allow them to remain. Of course I do not desire that itinerant vendors should have their living taken away, but some place or places might be set apart in most of our districts where such a market could be formed and placed under proper control, and so do away with a practice which is becoming a great nuisance. With regard to the temporary closing of the streets, I think it is intended to transfer this power to the local authority. I may say, so far as my district is concerned, if it is necessary to block a road on an emergency I do not go to the County Council for consent. Of course if I have to close the street for a couple of months, to relay paving or construct a sewer, application is made. The Act of 57 George III. gives certain power to local authorities to carry out works of street improvements, but the process is tedious and cumbersome, and the award of the Court in case of dispute is rarely satisfactory. The County Council intend to introduce a bill to enable local authorities to purchase property compulsorily for public purposes. It is proposed to transfer important powers to local authorities. The most important of these duties is that of the work of district surveyors. Should this be transferred to the local surveyor, I hope the authorities under whom he may serve will properly appreciate and value the extra duties thus thrown upon him, as was mentioned by Mr. Weaver in his remarks on this branch of the subject. Mr. Barber in his admirable paper only refers especially to two Acts of Parliament, thus touching the fringe of this important subject. According to Woolrych, late edition, there are no less than 37 statutes under which we have to carry out our duties, and since 1888 there have been some ten Acts of Parliament passed; in fact, during the last two sessions Amendment Acts were showered upon us like leaves in autumn. I am very anxious that some practical results should come from this meeting, and therefore throw out the suggestion of consolidation of the existing Metropolis Management Acts, as was done in 1891 when the Public Health Act was passed. This would be of very great service to all engaged in local affairs, and much simplify our work. Many must have found, like myself, great difficulty in looking into the Local Management Acts for guidance. Directly you fixed upon a particular clause meeting a difficulty, you also found in a

footnote half the letters of the alphabet referring you to old Acts of Parliament; and by the time you had searched them through, a very vague and foggy idea was obtained of what was the law. If these Acts could be consolidated by a combined body of lawyers and surveyors going through the various Acts, eliminating clauses which are useless, extending and amending others up to date, it would be, I feel sure, a very great advantage. My suggestion is that you should look rather to a proper consolidation and revision of the powers of local authorities, than to a tinkering of the existing Acts, if I may use the term. Whether when the district councils are formed, or now, is the time to do this, I am not prepared to say; but it is possible, in my opinion, to very much simplify the powers under which we act by some such process as this. I am sure our best thanks are due to the Author of the paper, Mr. Barber, for the careful attention he has given to the subject, and for attending here this evening at considerable personal inconvenience and risk to his health. I am sure on your behalf I may wish him a speedy recovery.

Mr. J. Patten Barber replied in the following terms:—

Sewers.—I believe that a provision in the Act, as suggested by Mr. Blair, enabling the vestries and district boards to make a specific charge for supervision of 5 per cent. on the cost of the work would be found inconvenient, owing to the difficulty in ascertaining the cost of the work, which is not carried out by the local authority, but by the person laying out the estates on which the sewers are constructed.

Drainage of Existing Houses.—Mr. Blair does not agree with the interpretation of "sufficient" as applied to a drain, in sec. 73, first Act, on the ground that the section empowers a vestry or district board to prescribe the material, levels, fall, &c., of the drain to be provided to such a building as this section is applicable to, and the apparatus and appliances which shall be furnished in connection with such drains. Nearly the whole of the matters which this section enables the vestry or district board to require, are accessories to the drain which has to be provided to a building not drained by a "sufficient drain," and their purpose is stated. Now it is clear that a drain described as not "sufficient" could not be made so by the provision of the accessories mentioned in the section, or it would have been provided that such a drain should be furnished therewith. But the section contains no such provision; the building which is found not to be drained by a

"sufficient drain" must, according to this section, be provided with a new drain. If, therefore, the drain not found "sufficient" cannot be made so by the provision of the accessories mentioned in this section, it could only be on account of its discharging capacity being insufficient, that being the only matter which would be unaffected by these accessories. The word "sufficient" therefore relates to the size or to the discharging capacity of the drain, and not to its being furnished with suitable accessories. Again, the function of a house drain is to carry off the sewage discharged into it; if it does this the drain is "sufficient," whatever may be its other imperfections. It appears, therefore, that however faulty a drain may be, so long as it is capable of carrying off the sewage discharged into it it could be successfully contended that it was a "sufficient drain," and the local authority would be unable to enforce compliance with requirements made under this section. Mr. Weaver considers that the Public Health (London) Act, 1891, gives the local authority sufficient power to deal with the drainage of existing buildings. A comparison of sec. 4 of that Act with the section under consideration, will show how much more extensive and specific are the powers conferred by the latter. Under the Public Health (London) Act the abatement of nuisances may be secured, but systems of drainage and sanitary appliances bad in design and construction cannot be abolished and replaced by improved and efficient ones, as they could be if this section were altered as suggested. Mr. Lovegrove's contention, that the powers of a local authority should not extend further than may be necessary to secure the abatement of nuisances, is at first sight reasonable. But a nuisance may be abated, whilst drains with uneven gradients and laid in irregular and tortuous lines, and numerous other faulty matters, may remain, which the local authority is powerless to require should be replaced by a proper system of drainage and efficient sanitary appliances, because their powers are limited to the extent advocated by Mr. Lovegrove. It seems reasonable that when such a condition of things is found upon premises, the owner should be required to remove all such drains, &c., and to carry out a more satisfactory system in accordance with present-day regulations.

Drains under Roads.—Those who have spoken on this subject have not referred to the defect in the Act pointed out in the second sentence of the paragraph dealing with this subject. One advocates that the portion of the private drain which is under the

road should be laid by the owner of the building with which such drain is connected. The owner can do this now, provided the local authority will allow him; the matter is, therefore, in their control, and legislation respecting it is unnecessary. A second speaker states that in the event of a private drain under a road requiring reconstruction or unstopping, the local authority can do the necessary work and charge the owner of the drain with the expense incurred. These remarks do not touch the point raised in the paper, which refers to a private drain through which several houses belonging to different owners are drained.

Paving, Draining and Repairing Courts, &c., not being Thoroughfares.—Two suggestions have been made in the discussion of this part of the paper: (*a*) That such courts, &c., should be paved as new streets, under sec. 105, first Act. The objection to this is that the vestry or district board would have to maintain the paving. (*b*) That such courts, &c., should be repaired under the Public Health (London) Act, as insanitary. This has been tried, and the difficulty of proving who is responsible for paving not used exclusively by the owner or occupier of one building, but by the several owners or occupiers of buildings in the court, has made it impossible to succeed. The ownership of a court is never, in the author's experience, found to be vested in one person, and where there are numerous owners it is impossible to ascertain the extent of their several liabilities. None of the difficulties or objections with which these two suggestions would be met, would be experienced if the alteration suggested in the paper were made.

Breaking-up Streets.—It has been stated in the discussion that if a trench opened by a gas or water company subsides after it has been reinstated by the vestry under an agreement with the company, the surveyor requires that a second voucher be sent, and that he succeeds in obtaining this, and thereupon repairs the trench a second time at the expense of the company. There is no legal obligation to send in the second voucher, and where a vestry agrees with a company to reinstate paving which they disturb, it is very doubtful whether the cost of a second reinstatement, necessitated by the subsidence of the trench, could be recovered. The opening of roads in emergencies, to which Mr. Blair calls attention, is not dealt with in the paper, as the existing provision in the Act, that notice shall be given within twelve hours after beginning to make such openings, is considered satisfactory.

Mr. Lovegrove appears to doubt the practicability of the fifth suggestion, but a similar provision is in force both in the metropolis and in the provinces—in the former under Michael Angelo Taylor's Act, and in the latter under the Gasworks Clauses Act, 1847, and the Waterworks Clauses Act, 1847. In the first-mentioned Act, however, an opening made for the purpose of repairs is only to be kept in repair for three months after being made—a curious provision, as there appears to be no reason for the time during which such an opening is to be maintained being less than one made for the purpose of laying a new main. The Gas and the Waterworks Clauses Acts, 1847, referred to by Mr. Angell, only apply to works authorised after the passing of those Acts, and they would, therefore, not be applicable to the metropolis. The last suggestion in the paper—respecting the alteration of mains, &c.—has met with no support in the discussion, those who have referred to it having considered that such alterations being required for the purposes of the local authority, should be made at the expense of such local authority. My suggestion is not without precedent, as the Telegraphs Act, 1863, contains a provision similar to that suggested in the paper. The provision is a reasonable one, for the power of a local authority to alter and improve a road should be predominant, inasmuch as it is the interest and convenience of the public which it has to consider in regard to such works; and all mains, pipes, &c., in a road should remain only so long as they do not interfere with the functions and duties of the local authority with respect to a road. The view advocated by those who differ from me is one which makes the position of the local authority subordinate to the interests of the companies.

Private Paving.—The paving which I had in view is that which adjoins the public footway, and over which the public walk, although separated therefrom by a straight joint; and the alteration contemplated was only such as could be carried out without affecting the property. The raising of private paving to such an extent as to cause injury to the premises to which it is attached, is a matter on which the Author would scarcely venture to express a general opinion.

Street Improvements.—The provisions of Michael Angelo Taylor's Act, enabling a vestry or district board to carry out street improvements, have not been overlooked, very many of such works being carried out in Islington every year under the Act.

But there are various improvements mentioned in the section referred to in the paper which are not covered by Michael Angelo Taylor's Act, and to carry out such improvements the consent of the London County Council would have to be obtained, a proceeding which is thought unnecessary.

I appreciate the interest which has been taken in the paper, and the very exhaustive discussion which has arisen upon it, and I particularly desire to acknowledge Mr. Blair's able and careful contribution to the discussion. I have not dealt with every subject respecting which the Acts require amendment, as it would be impossible to do so in a single paper, but I trust that the subject will be taken up by the Association, which, in my opinion, is the body from which any authoritative suggestions for the amendment and alteration of the existing Acts should proceed.

Mr. WHEELER moved that a committee of surveyors be appointed to go into the suggestions made in the paper and report to the Council. He said—I have no doubt after threshing it out there would be many more suggestions to add to those in Mr. Barber's paper. The Council would send these suggestions to the various local authorities in the metropolis, with a view of obtaining legislation.

Mr. BLAIR: I cordially agree with the proposition and have much pleasure in seconding it. I can see it is a big undertaking, and one which the Council and the Association must not expect a report upon at its next meeting, or probably within a period of months, but I think it is one which will benefit by such consideration.

Mr. DODD proposed that Messrs. J. P. Barber (Islington), C. H. Lowe (Hampstead), W. Weaver (Kensington), W. N. Blair (St. Pancras), and G. R. Wheeler (Westminster) form the committee. He said, those gentlemen have had much experience in carrying out the Metropolis Management Acts, and I am sure much good will result from their deliberations.

Mr. LOVEGROVE seconded the proposition, which was adopted.

The CHAIRMAN moved a vote of thanks to the Vestry of Westminster for the use of the council chamber for the meeting, which was heartily accorded.

Mr. WHEELER: I will convey the thanks to the Churchwardens and Overseers. The Town Hall will come under the control of the Vestry at the end of this month.

DISTRICT MEETING AT KING'S HEATH.

March 28, 1896.

Held at the Institute, King's Heath.

E. R. S. Escott, M. Inst. C.E. President, *in the Chair.*

The chairman of the Rural District Council (Mr. T. R. Bayliss) offered the Members a hearty welcome, and referred to the fact that the visit was the first that the Association had paid to a Rural District.

Mr. A. T. Davis was unanimously re-elected Honorary Secretary for the Midland Counties District.

Letters were read from several Members who were unable to be present.

The following paper was read and discussed.

FOURTEEN YEARS' WORK IN A MIDLAND SUBURB.

By ROBERT GODFREY, Assoc. M. Inst. C.E.

The district which is included within the jurisdiction of the Rural District Council of King's Norton comprises the parishes of King's Norton, Northfield and Beoley in the county of Worcester, being the only parts of the King's Norton Union which are not under the control of urban councils.

It extends from the boundary of the city of Birmingham on the north to the boundary of the town of Redditch on the south, a

distance of 10¾ miles, and from the parish of Yardley on the east to Halesowen on the west, a distance of 7 miles.

It has a total area of 22,106 acres. In 1881 the population was 19,476; in 1891, 5272 inhabited houses, with a population of 28,300, and in the present year it is estimated that it has reached 34,000, an increase of 74 per cent. in fifteen years, a rate of increase almost American in its rapidity, and probably greater than any other district not adjoining the Metropolis.

Geology.

The district forms part of the great midland tableland which constitutes the watershed of the Trent and Avon and Severn valleys, the Lickey hills in the parish of King's Norton being the dividing line. The rainfall from the northern slopes reaches the Trent, while that from the southern slopes passes into the Avon, and thence into the Severn.

The eastern part of the district is on the Keupar sandstone formation, with great beds of clay prevailing, interspersed with alluvial deposits of water-worn gravel. On the western side the Permian formation is manifest, one lane in Northfield being cut through a deposit of Permian brescia, which has attained almost classic rank, forming, as it does, one of the typical illustrations in the standard geological work of Jukes.

North of the village of Northfield there is an irruption of the Bunter pebble beds; while at the Lickey the Cambrian formation is present through an upheaval of the earth's crust.

There is no mineral wealth except clay, from which a fairly good building brick is made for local use.

Rural District Council.

Prior to the Local Government Act, 1888, the administration of the district was under the following bodies or persons:—

1. The Rural Sanitary Authority for the purposes of the Public Health and Cognate Acts.

2. The King's Norton Board of Surveyors for highway purposes in King's Norton.

3. The Northfield Highway Board for highway purposes in the parish of Northfield.

4. A parish surveyor appointed by the vestry for the parish of Beoley.

In 1889 the County Council took over the charge of the main roads, thus causing a fifth authority to exist within the area. This state of things lasted till the Act of 1894, whereby all the powers, duties and liabilities of the four first were amalgamated in one body, termed the Rural District Council of King's Norton, the County Council still retaining the main roads.

Urban Powers.

In 1874 and 1881 the Rural Sanitary Authority applied for, and obtained power to make bye-laws regulating buildings and to water streets; and in 1883, and subsequently, additional powers have been obtained (see Table II.), so that except in name the Rural District Council is invested with powers almost coincident with any urban district not governed by a private Act.

Sewerage within Drainage Area.

From its geographical position on the southern boundary of the city of Birmingham, with being traversed by valleys all trending to the River Rea, which passes through Birmingham, and the subsoil being of a stiff retentive clayey character, the difficulties which the Rural Sanitary Authority had to face were very great.

After a lengthened and searching enquiry by the late J. Thornhill Harrison, Local Government Board Inspector, a Provisional Order was sanctioned by Parliament in 1877 constituting a special drainage district, which comprises the city of Birmingham and all the surrounding suburbs whose watersheds lead to the Trent, so that within that area no sewage farm exists, but all sewage is discharged to the Drainage Board's land at Tyburn.

This district for sewerage purposes is governed by a body known as the Birmingham, Tame and Rea District Drainage Board, to which all the contributory districts send representatives, Birmingham having the preponderating representation.

This Drainage Board took over the Saltley Sewage Works belong-

ing to the city, and established the Tyburn sewage farm (about 1400 acres) lower down the valley of the Cole, and to one or other of these outfalls all the sewage of the Drainage Board area is conducted.

The Rural Sanitary Authority commenced a system of sewers in 1878, which were only just completed when the author was appointed in 1882. And since that time extensions have been constantly in progress to meet—and often to anticipate—the growing needs of the district.

No less than thirty miles of sewer have been added since 1882, both within the drainage area and in the populous parts without that area.

In order that the sewage from the drainage area should reach the outfalls of the Drainage Board, it is necessary that it should pass through the existing city sewers, and for that purpose provision was made in the Order of 1877 (Sec. xxvii.) whereby the City of Birmingham was to receive a perpetual annuity "to be settled and secured by agreement on the basis of the population or the number of inhabited houses." Forty gallons per head per day being the maximum quantity.

This payment was $2\frac{1}{2}d.$ per head of the population in the drainage area; but on the completion of the Cole valley sewer it was raised to $5\frac{1}{2}d.$ per head per annum.

The sewers of the council join the city sewers at six different points, and gaugings are taken periodically to see whether the stipulated quantity is exceeded.

The Drainage Board levies a precept on the district for a contribution based on the number of rated tenements (houses or lands) calculated over the whole area of the Drainage Board. The overseer levies this as a separate rate upon all properties within the area.

The capital cost of the sewers within the King's Norton and Northfield drainage area is levied on the whole parish in which the outlay occurs.

Thus the sewerage within the drainage area costs :—

1. Interest and principal on capital cost.
2. Way leave through city sewers.
3. Proportion of expense of maintaining the sewage farms.

The last two items amounting in 1895 to 1739*l.* 2*s.* 6*d.*

Sewerage without the Drainage Area.

Outside the drainage area there are several villages which have had to be dealt with separately. Northfield Village, Bartley Green, and Woodgate and Moor Street, have each had to be provided with outfalls, all of which have been carried out without recourse being had to mechanical power.

King's Norton Village was the last which required treatment, and in 1892 a scheme was submitted to, and approved by the Local Government Board, but before it could be carried out or even commenced, a large building estate was put on the market, in an adjoining valley. The only piece of land available for an outfall had been secured, and the whole scheme had to be re-cast.

Lifting had to be resorted to, and eventually Shone's ejectors were adopted. A central station was established at Lifford, from whence compressed air is sent 2000 yards into the area termed the Extension Area. The sewage from there is propelled a height of 70 feet to the top of the hill separating the two valleys, and from there it flows by gravitation to the outfall, into ejectors which lift it into the tanks.

The plant provided consists of two boilers 20 feet by 7 feet, fitted with Lee Howle & Co's forced draught, two Hughes and Lancaster's horizontal engines and compressors, with Shone and Ault's valves, capable of compressing 109 cubic feet of free air per minute.

The sewage is received into an elevated carrier, and during its passage along this to the tanks it receives the milk of lime and protochloride of iron, which becomes thoroughly incorporated with it before it enters the tanks. In the tanks, which are worked in pairs, it undergoes a period of quiescence and deposits the heavy matter. The supernatant liquid is then drawn off and passed through the Bacillite battery, which is the peculiar feature of the method of treatment adopted.

The liquid is now subjected to the action of steam and carbonic acid gas, the steam being charged with a germicide composed largely of carbolic acid, the action of which, it is claimed, effectually destroys the putrefactive organisms in the sewage, thereby preventing any secondary decomposition. After the liquid leaves the Bacillite battery it is passed into two of Thwaite's filters, which are capable of passing 27,000 gallons of liquid per square yard per

day. The filters are 8 feet in diameter, and by reversing the flow of the liquid are self-cleansing.

From the filters the effluent passes direct into the river, and as it is a very small one, most exceptional care has to be taken to prevent any cause of complaint. The city of Birmingham is on the watch, and at all cost pollution of the river and consequent litigation must be avoided. Irrigation is not adopted owing to the unfavourable character of the subsoil; and although 14 acres have been purchased, only part is used for the buildings and some osier beds.

The system has not been in operation sufficiently long to enable the cost to be accurately given.

The works have been designed by the Author and carried out under the immediate supervision of the assistant surveyor, Mr. J. H. Webb, whose valuable assistance is cordially acknowledged.

New Sewers.

Since 1882, new sewers to the extent of 30 miles 6 furlongs have been laid, and schemes for another 2 miles are now in course of preparation.

Public Lighting.

In 1883 and 1884 an attempt was made in Parliament to sever the gas supply of the district from Birmingham, but the effort was not successful. At that time each public lamp cost 2*l.* 8*s.* 6*d.* per annum, including all repairs, lighting, &c.

In 1885 the outside authorities were offered gas for street lighting at $\frac{12}{25}$ of the lowest current price per 1000 cubic feet. At that time large consumers paid 2*s.* 1*d.* per 1000, so the offer meant gas at 1*s.* per 1000 cubic feet, provided the cost of lighting, maintenance, &c. was undertaken by the local authority. The Rural Sanitary Authority at once closed with the offer, and immediately realised a saving of 500*l.* per annum. The average cost now, including gas, is 32*s.* per lamp, so that with 1050 lamps a saving of 866*l.* 5*s.* is effected. The incandescent system has been applied to seventy-six lamps. Particulars of twenty-five which have been up more than a year are given in Table III.

The difficulty of lighting from the outside of the lanterns, and

of protecting the mantles against the effect of the wind, has been overcome by a device which can be seen both in the room and in the lamps in the High Street.

New Streets and Roads. Section 150, Public Health Act, 1875.

Twelve miles of new roads and streets have been made by landowners, and six and a half miles have been made good under section 150, Public Health Act.

Highways.

On April 1, 1895, by the Parish Councils Act, all the roads in the district (except the main roads) were transferred to the Rural District Council. The total length is 129 miles.

A steam roller (10-ton) was at once obtained, additional horses and carts purchased, and the whole district divided into nine sub-districts, each under a foreman.

The Rural District Council has adopted a "Forward" policy, and is now applying to the Local Government Board for loans to carry out various schemes for widening and improving roads and bridges, the most important of which is the Raddle Barn Lane Improvement, which will entail the reconstruction of two bridges and the widening of a considerable length of road. (See Appendix.)

The district is peculiarly devoid of good road metal; the nearest which can be obtained is from the basalt at Rowley Regis, 8 or 10 miles distant. This costs 6*s.* 6*d.* per ton delivered to wharves in the district.

When the Local Government Act of 1888 was passed, rural authorities had not the option of maintaining their own main roads, but this council is placed in such an exceptional position that they are making a strenuous effort to have the charge of the main roads in the district restored to them.

Being so essentially urban, and bordering on the city of Birmingham, there is every reason to contend that with headquarters at Worcester, 20 miles away, the care of these roads would be better in the hands of a local authority than under a central organisation.

As an illustration of the character of the traffic, a census was taken on Feb. 8 to 14 on the three main roads which intersect the district, and 15,727 vehicles were counted between 4 a.m. and 11 p.m. on the seven days, 40 per cent. of which was heavy, and 60 per cent. light traffic.

With eight railway stations within eight miles of the city boundary the urban character of the district is clearly manifest.

Cemeteries.

In 1895 the Lodge Hill cemetery of seventeen acres was completed in the parish of Northfield, and tenders are now being invited for the fencing and laying out of another cemetery of thirty-two acres at Brandwood End for the parish of King's Norton.

Fever Hospital.

In 1888 a hospital for infectious diseases was completed at West Heath. It is built to provide thirty-two adult beds, but as the patients suffering from scarlet fever only are admitted, the majority of which are children, there is room for sixty. Plans have just been adopted for a house for the nursing staff, and instructions given for the preparation of plans for a small-pox pavilion. The cost up to date has been 9950*l.*, including site.

Small-pox cases were treated in a Dœcker tent, which will be burnt as soon as the new pavilion is ready. Admissions and deaths are given in Table IV.

The water supply of the hospital is from a well in the grounds 97 feet deep, from which the water is raised by a Halliday windmill 16 feet in diameter, into a tank holding 9000 gallons, about 30 feet above ground, and during the time the mill has been up the hospital has never been short of water. On some occasions 700 gallons an hour have been raised.

The hospital is connected with the Council's office by a private wire, which for a distance of 350 yards is carried through a sewer, and though it has been in use eight years it has worked well.

Water Supply.

The city of Birmingham has the monopoly of water supply in the parishes of King's Norton and Northfield, but there are parts of the district which they are unable to supply, and it has devolved upon the Rural District Council to take action. A supply is obtained from the East Worcestershire Waterworks Company for Rednal and Rubery on the south, and at Bartley Green a supply is being provided for that neighbourhood, containing about 1600 persons. A well has been bored through the Bunter pebble beds to a depth of 280 feet, and a 20,000 gallon tank is being erected. Within the tower supporting the tank, two Hornsby-Akroyd oil engines will be placed, and from the tank the whole of that part of the district will be supplied.

In both these cases the distributing mains have been laid by the city of Birmingham, the District Council paying 5 per cent. interest on the outlay. This course was adopted owing to the fact that the city has the monopoly but cannot furnish the supply without pumping; should they do so in the future the interest will cease.

Dust Removal.

In 1882 there was no organised system of dust removal; the prevailing receptacle was the wet midden. Gradually the whole of the drainage area, together with the villages of King's Norton and Northfield, have been embraced in a scheme whereby the whole of the refuse is removed by the employés of the Rural District Council. Last year some 8000 loads of refuse were removed. Water-closets and tubs are rapidly superseding the ancient abominations, and wherever sewers are available nothing but water-closets are permitted in new buildings. Duckett's slopwater closet is being largely adopted.

The contents of the ash tubs are tipped into disused clayholes, but this cannot last for long. An attempt is to be made at Lifford to burn some of the dry refuse by aid of forced draught, but as the district increases the necessity of a destructor will become apparent. The land is ready, access to it by canal is available, and it only needs the assent of the Rural District Council to have the machinery of the district complete.

Fire Brigade.

Eleven years ago a start was made to establish a fire brigade, and a hose cart was obtained. Matters have gone on, till now there are two efficient brigades, one at King's Heath and one at Selly Oak, provided with manual engines. These are shortly to be replaced by steam fire engines, and the manuals placed at King's Norton and Northfield.

An additional station has just been established at Stirchley, for the protection of a populous part of the district which has increased very rapidly.

Since the establishment of the brigades 96 fires have been attended.

New Houses.

As an illustration of the rapid growth of the district, plans for 4723 houses have been before the building Committee and approved. (See Table VI.)

Tramways.

The Birmingham Central Tramway Company have laid down new lines to Moseley and King's Heath, with steam as a motive power; and on the Bristol Road have adopted the electric accumulator system, with generating station at Bournbrook.

The opportunity was taken when the King's Heath line was being laid, to widen an existing bridge from 18 to 36 feet.

A bridge at Bournbrook was also widened, jointly, in 1883.

Depôts.

Owing to the wide character of the district the plant of the Rural District Council is kept at three depôts, but it is proposed to amalgamate two of these on a plot of freehold land belonging to the Council, and to increase the stabling accommodation, &c.

The Council has just given instructions to purchase a site at Selly Oak for the purposes of depôt, fire station, mortuary, &c.

Offices.

The Council cannot boast of a palatial suite of offices at present, but the right of pre-emption to a very suitable site has been secured, and during the summer it is probable that steps will be taken to provide suitable accommodation for all the officials of the Council.

Finance.

In the appendix will be found some financial figures which may be interesting to some of the Members.

TABLE I.

Financial Statistics.

Loans for King's Norton Parish—	
For Sewerage	£59,121
Public lighting	600
Road making	7,260
Scavenging	2,400
Cemetery (land only)	6,800
	£76,181
Amount outstanding £40,519.	
Loans for Northfield Parish—	
For Sewerage	£21,593
Public lighting	350
Road making	2,230
Cemetery	15,000
Costs of gas bill	1,340
Water supply	1,650
	£42,163
Amount outstanding £27,291.	
Loans on Common Fund—	
For Hospital	£9,950
Steam roller	330
	£10,280
Rateable value—	
Lady Day, 1893	£171,379
„ 1896	200,695
Total Rates (inclusive)—	
Beoley	3*s.* in the £.
King's Norton	5*s.* 5*d.* in the £.
Northfield	5*s.* 10*d.* in the £.

TABLE II.—Table showing Urban Powers with which the District Council is Invested.

Year.	Act.	Sect.	Powers.
1874	Local Government Act, 1858.	..	Bye-laws as to new buildings.
1881	Public Health Act, 1875.	..	Watering streets.
1883	" "	25	Penalty on building houses without drains.
"	" "	39	Public necessaries.
"	" "	42	Cleansing streets and removal of house refuse.
"	" "	44	Making bye-laws for the prevention of nuisances, &c.
"	" "	45	Provision of receptacles for deposit of rubbish (street orderlies).
"	" "	66	Provision of fire plant.
"	"	112	Offensive trades.
"	" "	113	" "
"	" "	114	" "
"	" "	155	Regulating line of buildings.
"	" "	156	Buildings brought forward (now Sec. 3, Public Health Act, 1888).
"	" "	158	Commencement and removal of works contrary to bye-laws.
"	" "	160	1. Naming streets and numbering houses. 3. Ruinous and dangerous buildings. 4. Precautions during the construction and repair of streets and houses.
"	"	169	Provision of slaughter-houses.
"	" "	170	Notice to be affixed to ditto.
"	" "	171	2. Police regulations as to fires. 4. Hackney carriages.
1884	" "	150	Making good Heeley Road.
"	" "	"	Making good six streets.
1887	" "	"	Making good thirteen streets.
1888	" "	"	Making good five streets.

TABLE II.—*continued.*

Year.	Act.	Sect.	Powers.
1890	Towns, Police Clauses Act, 1847.	28	Obstructions and nuisances in streets.
	Ditto Act, 1889.		Amending provisions of Act 1847 as to hackney carriages.
1891	Public Health Amendment Acts, 1890.	20	Sanitary conveniences (public).
,,	,, ,,	22	,, ,, (for factories)
,,	,, ,,	23	Power to make bye-laws extending Sec. 157 of Act of 1875.
,,	,, ,,	24	*re* Rooms over privies.
,,	,, ,,	26	*re* Bye-laws as to removal of house refuse.
,,	,, ,,	27	*re* Keeping common courts and passages clean.
,,	,, ,,	29	*re* Slaughter-house licences.
,,	,, ,,	30	*re* Change of occupation of slaughter-house.
,,	,, ,,	31	Revocation of licences.
,,	,, ,,	34	*re* Hoarding during progress of building.
,,	,, ,,	35	Repair of cellars under streets.
,,	,, ,,	36	Ingress and egress to public buildings.
,,	,, ,,	37	Safety of platforms, &c.
,,	,, ,,	38	*re* Danger from whirligigs.
,,	,, ,,	39	Refuges in streets.
,,	,, ,,	40	Cabmen's shelter.
,,	,, ,,	42	Statues and monuments.
,,	,, ,,	43	Trees in roads.
,,	,, ,,	44, 45	Parks and pleasure grounds.
,,	,, ,,	46	Public clocks.
1891	Public Health Act, 1875.	150	Making good one road.
1894	,, ,,	,,	Making good one road.

TABLE III.

SELLY OAK, 25 LAMPS.

Present consumption, twelve months ending 18th December, 1895	12,650	cub. ft.
Previous consumption, twelve months ending 28th September, 1894	39,020	,,
Saving on each lamp	26,379	,,
Saving on 25 lamps	659,475	,,
At 1*s.* 1*d.* per 1000 cub. ft.	£35 14 4	
5 per cent. discount	1 15 9	
Net saving in gas	£33 18 7	

The total number of mantles used and chimneys replaced was:—

	£	*s.*	*d.*
Mantles, 227 at 1*s.*	11	7	0
Chimneys, 77 at 1*s.*	3	17	0
Forks, 19 at 1*d.*	0	1	7
	£15	5	7

leaving a net gain of 18*l.* 13*s.* by the use of incandescent burners.

The cost of the burners and fittings was 25 at 16*s.* = 20*l.*, so that the first year's saving in gas leaves only 27*s.* capital cost to be met out of next year's savings.

The largest number of mantles used by any one lamp (No. 9) was 14, the smallest number (No. 18) was 6.

TABLE IV.

ADMISSIONS TO HOSPITAL.

Year.	Scarlet Fever.	Deaths.	Small-Pox.	Deaths.
1883	21	..	10	1
1884	20	..	3	
1885	7	..	1	
1886	38			
1887	45			
1888	52	1		
*1889	156	3		
1890	371	13		
1891	156	7	2	1
1892	106			
1893	243	13	1	
1894	146	1	34	4
1895	139	7	10	1
Totals ..	1500	45	61	7

Percentage of Deaths to cases treated:
Scarlet Fever, 3 per cent.; Small-pox, 11·4 per cent.

* Prior to this date temporary provision was made.

TABLE V.

Death Rate.

Year ending December.	Estimated Population, middle of Year.	Zymotic Death Rate.	General Death Rate.
1873		3·4	15·6
1882	19,683	1·42	13·21
1883	19,876	·04	13·51
1884	20,265	·78	14·00
1885	22,700	·44	12·95
1886	23,560	1·31	13·62
1887	24,453	0·94	12·71
1888	25,392	·55	10·23
1889	26,367	·70	10·61
1890	28,396	·73	12·04
1891	28,300	·77	12·36
1892	28,562	·70	12·52
1893	29,884	1·03	15·35
1894	30,977	·60	10·87
1895	34,000	·80	12·27

TABLE VI.

Number of New Houses submitted for Approval (exclusive of Alterations, Additions, etc.) and New Roads made between January 1882 and December 1895.

Year.	King's Norton Parish.		Northfield Parish.		Besley Parish.	
	Roads.	Houses.	Roads.	Houses.	Roads.	Houses.
1882	1	71	..	20	1	
1883	..	124	..	32		
1884	..	174	..	26	..	1
1885	3	122	..	72		
1886	1	155	..	10	..	2
1887	3	167	..	95	..	4
1888	..	127	..	152	..	3
1889	7	140	1	198	..	2
1890	7	208	..	204		
1891	4	312	3	124		
1892	9	259	2	306	..	2
1893	5	292	9	84	..	8
1894	10	405	1	90		
1895	19	498	6	233	..	1
Totals ..	69	3054	22	1646	1	23

TABLE VII.

PROJECTED WORKS.

*Brandwood End Cemetery, laying out, fencing, chapels	£9,500
Raddle Barn Lane Improvement	3,000
West Heath Sewerage	2,500
*Silver Street (extension)	354
*Quarry Lane (widening)	300
*California Bridge (rebuilding)	102
*Nurses' Home (Hospital)	2,500
Beoley Brook Bridge	1,000
Weoley Park Road	700
New stables, fire station, &c., Selly Oak	1,500
New offices and stabling, King's Heath	3,500
Avenue Road Improvement	400
	£25,356

* Loans applied for.

DISCUSSION.

Mr. J. T. EAYRS: I think it might be useful to some of the Members if Mr. Godfrey were to explain more fully the portion of his paper with reference to incandescent gas lighting for street lamps. He has some arrangement for the lighting of the lamps which has proved advantageous here and may be useful to other districts.

Mr. R. GODFREY exhibited a lamp which he had had temporarily fixed on the stage of the Institute, and showed the method of lighting by a torch from an improvement on the Wiesbaden spoon. The method of lighting adopted has proved most convenient, and of great value in preserving the life of the mantle—the most serious item in an installation of incandescent lighting.

Mr. DAVIS: I think it would be interesting if Mr. Godfrey would explain to us why he adopted this plan of lighting rather than the bye-pass, to which we are so accustomed?

Mr. R. GODFREY: I found the bye-pass damaged the mantles more than the explosion of lighting. I also found the bye-pass light often got blown out. I tried the bye-pass first, but it was not successful. You will find some particulars given in the tables, showing we have already saved half the cost of the installation. At the present time the cost of installing the incandescent system would be one-half the cost given here. Eighteen months ago the cost was 16*s.* per lamp, now it would be 8*s.* per lamp.

Mr. T. R. Bayliss: Is there not some escape of gas from the bye-pass? When a room is lighted with the incandescent burner, and has been closed all night, there is a strong smell as of gas on going into the room next morning.

Mr. R. Godfrey: It is a smell as of burnt tallow. It is some substance in the mantle which gives off a smell which is unpleasant and very objectionable.

Mr. B. Godfrey: The effect of the bye-pass on a burner in my house has been a complete failure—sometimes refusing to light, and other times giving off a fearful smell.

Mr. A. T. Davis: I have an incandescent burner in my house which has been there since January 1, and it has only gone out once during that time. I have not experienced any smell in the slightest degree, neither has the mantle broken or anything of the sort. It has been a decided success.

Mr. Hall: I have had some experience with the incandescent burners. Of two burners in my own house, one had the unpleasant smell complained of, and the other, burning at the same time, had no smell whatever. I had a gas fire burning in the same room, and three burners. Some time ago I found the cause of it, which was a small leakage from the top of the burner. If you take the burner to pieces, you will find it is not properly made, it is a number of stampings put together. With regard to the durability of the mantles, I had one in constant use for ten months. It gradually became so worn that only one-third of its surface emitted any light; it lost its power of incandescence. The next one lasted two days; the next a fortnight; and then I got another good one. I find they are not at all a reliable mantle.

Mr. J. T. Eayrs: I am afraid we are drifting rather on to the subject of domestic lighting than street lighting. The object of this paper is street lighting only, not whether these mantles smell in a closed confined room. The question of smell does not concern us here, because the gas is consumed in the streets. I have a considerable number of these lamps at work, but I am not at present prepared to give you any statistical information as to the life of the mantles, which is the most serious part of an installation of incandescent lighting. But generally speaking as to this system of incandescent lighting, I think it has a very great future before it. One point we have to keep in view is the efficient lighting of the streets and the exercising of the greatest economy in producing or distributing that light. Take an ordinary street

lamp burner which burns 4 feet or 5 feet per hour, and replace it with an incandescent burner: you get no economy in gas, but you get a much superior light for the quantity of gas consumed. If you have a bye-pass to the burner, you use more gas than with an ordinary street lamp burner. I am trying experiments with incandescent burners constructed to burn $2\frac{1}{4}$ feet instead of $4\frac{1}{2}$ feet of gas per hour, with very good results. If you put one of these burners in a street lamp, and compare with another lamp with an ordinary burner, you find a great improvement, and you are saving at the same time about half the quantity of gas. I am using a $2\frac{1}{4}$-feet incandescent burner to replace an ordinary 5-feet burner, and two $4\frac{1}{2}$-feet incandescent burners to replace burners in large lamps consuming about 24 feet per hour. In these cases you get a much better light with the incandescent burners, and the saving in gas pays the cost of the mantles.

Mr. CAMPBELL: I should like to ask Mr. Godfrey how there is so large a saving of gas. Mr. Godfrey states that the present consumption of the lamps for twelve months is 12,650 cubic feet, as compared with a previous consumption of 39,020 cubic feet. The latter appears to be an extraordinary consumption, as the average of the country is about 20,000 cubic feet.

Mr. GODFREY: All the lamps referred to were burning 10 cubic feet per hour, now they are burning 4 feet.

Mr. C. H. LOWE: I should like to ask as to the effect of the vibration caused by heavy and continuous street traffic on the life of the mantles. They burn very well in rooms or on a steady platform, as at present, but when they are put in the ordinary street lamps the mantles appear to suffer very much from the effects of vibration. Mr. Robson, my respected colleague at Willesden, has reported fully upon the loss caused thereby very recently.

Mr. J. T. EAYRS: A great many of my incandescent burners are fixed on lamps on main roads with steam trams running backwards and forwards, and I have experienced no difficulty from vibration and no greater destruction of mantles than in streets without trams.

Mr. WHEELER: I have tried the incandescent gas lamp for four months, and found the vibration ruinous to the mantles. In four months we had 91 mantles to pay for, which doubled the cost of the burners. We have, therefore, abandoned the use of the burners for the present.

Mr. SCORGIE: Having a district subject to heavy traffic, I can

bear out what has been said as to the effect of vibration on the life of the mantles. We had six lamps as an experiment, and we have used as many as two mantles in a night. We have tried all sorts of burners, and now the South Metropolitan Gas Company think they have a burner which will succeed.

Mr. C. H. Cooper: I cannot see that the use of the Wiesbaden spoons for lighting the incandescent lamp produces any saving. In the year which Mr. Godfrey has tried 25 lamps, he has used an average of nine mantles for each lamp. With the ordinary method of lighting, the average number of mantles per lamp is estimated at eight, so I do not see any saving in the mantles.

Mr. Pickering: Referring to the filters, I notice Mr. Godfrey says the filters are capable of passing 27,000 gallons of liquid per day. I should like to ask Mr. Godfrey whether he has actually tested the filters or whether they are merely figures of the patentee. A filter 8 feet in diameter is roughly about 5½ square yards, so that a filter this size would deal with 148,000, gallons per day, or the sewage from a population of say 7400, assuming a flow of 20 gallons per head. Personally I do not think the filters will do anything of the kind, so that I should like the author to say how he arrives at the figures given in his paper.

Mr. T. de Courcy Meade: I rise to move a vote of thanks to Mr. Godfrey for his paper. In the first place I must congratulate him in getting this paper circulated in time for us to consider. We have had a lot of trouble to get these papers out in time, but Mr. Godfrey has shown us it can be done. I would like to ask, with regard to the Bacillite system, whether Mr. Godfrey has had an analysis of the sewage and the effluent, and whether he can give us the quantity of chemicals used. I assume the sewage does not contain manufacturers' refuse; if this is so there will be very little variation in the character of the sewage, taking one day with another. The population at present connected with the sewers is small, I therefore assume that the sewage would be somewhat diluted by subsoil water.

Mr. Massie: I have pleasure in seconding the vote of thanks to Mr. Godfrey for his paper. I think he especially deserves the thanks of the rural Members in having the courage to ask you to attend a rural district, and I think he should be congratulated in having such a very large meeting of Members. There are one or two points in the paper that I take a very great interest in. I should like to say that Mr. Godfrey must have round him surveyors

who are not at all ambitious to enlarge their areas, or else, it being so essentially an urban district, he would have suffered like I have from having surveyors, I will not say greedy, but ratepayers so anxious to annex districts as soon as they see they are prospering at all; we have, unfortunately, to get a district into good working order, and as soon as we have done so we are immediately threatened with an annexation scheme. In the West Riding of Yorkshire, unfortunately, these annexation schemes come very frequently. I should like to ask Mr. Godfrey about his Infectious Diseases Hospital. I notice in the paper that they propose to treat small-pox on the same site as scarlet fever. I should like to know whether he has received any intimation from the Local Government Board that they will grant him a loan for the building of that small-pox hospital on the same site. The death rate is certainly exceedingly low. I wish we had a similar one in my own district. The highest seems to be about 15, and the lowest 10 per thousand per annum; but ours averages 18 per thousand. On page 127 Mr. Godfrey contends that the care of the main roads should be in the hands of the Rural District Council. In the West Riding of Yorkshire that is so. I have under my charge something like 30 miles of main roads. I know it is a rather debatable point, and I notice in one of the papers an article contending that the main roads should be in the hands of the county authorities. The difficulty in my district would be that the main roads would be so intersected with little urban authorities who have elected to maintain such roads, that, if the county claimed to maintain them they would have little bits here and there scattered all over the district. In the management of main roads in the West Riding we try to work entirely in harmony with the surveyor for the County Council. All that Mr. Godfrey wants to avoid—if I may give him a hint—is not to have the chairman of the County Council living in his district. If he does he will find complaints coming very frequently, and no doubt the chairman will forget that the same County Council are pressing us every week or month to prepare sewerage schemes, and if you have to cut the roads up for such purposes, you cannot get them back into order in a few months.

Mr. T. H. Yabbicom: I can answer the question which has been asked as to whether the Local Government Board will sanction a loan for hospitals for small-pox and other infectious diseases on the same site, because only this week I had an interview with Dr.

Thorne Thorne, and Mr. Gordon Smith, the architect of the Local Government Board, and they expressed the intention of the Board not to allow the two diseases to be treated on the same site at the same time. Consequently, we have to get two sites, one for the treatment of small-pox and another for the treatment of other infectious diseases. I notice the cost of the infectious diseases hospital at King's Heath for 32 beds is put at 9950*l.*, including site. That works out at 309*l.* per bed. I take it that does not include the administration block. Does it include the laundry for treating the articles used? Are there any isolation wards; and is the cost of furnishing included?

Mr. Willcox: I should like to ask Mr. Godfrey why the Bacillite people have altered their method of treating the sewage? If I remember aright, when I was at Kettering the carburetted steam was applied to the sewage itself, and not to the separated liquid. It was pointed out to me that one of the advantages of this method of treatment was that there was no smell from the sludge. I saw a great heap of the sludge at the depôt there, and practically there was no smell. If the steam is applied to the liquid only, I should like to ask whether the sludge is likely to be offensive? I read with astonishment the amount of work done by the Thwaites filters. I have had experience of sewage filters and never obtained results like that. I should like also to ask whether the sewage is treated by the quiescent or the continuous process in the tanks? I conclude it is the continuous process, and if so, I should like to ask how the nascent liquid is drawn off. Perhaps Mr. Godfrey will give us the capacity of the tanks, as that is very interesting information. Also as regards the night sewage, does he pump at night?

Mr. Richardson: As regards the site of the infectious hospital, I may say I have a hospital for treating small-pox on one side of the road, and for other infectious diseases on the other side of the road. We wanted to make some additions to the small-pox hospital, and the Local Government Board refused to give us a loan. The only land we could get was 400 yards away. I had an interview with Dr. Thorne Thorne, and he said we might dismiss all idea of ever getting a loan for a building within a quarter of a mile. His rule is strict, we did not get the loan.

Mr. W. Nisbet Blair: May I say one word as to the Local Government Board and infectious diseases hospitals. I cannot say what their practice is recently; I take it to be as various speakers have described it, but I know that ten years ago they did give

consent to a loan for pavilions for treating typhoid and scarlet fever in ground in which small-pox pavilions were placed. I carried out the plans, and at that time they sanctioned a loan for pavilions all within the same enclosure.

The PRESIDENT: I should like to ask a question as to Duckett's slop-water closet, whether in the time of frost and very severe weather there is any difficulty in the flow of the sewage? I should also like to ask the cost per 1,000,000 gallons of the chemicals put in the sewage? That is a rather important question. We have tried several experiments lately, and the cost varies from 22*s.* to 32*s.* 6*d.* per 1,000,000 gallons. That is rather more than one thinks it should cost. And even after that outlay you have to pass it over land for land filtration. The Local Government Board requires that. Then with reference to the hospitals, I think the present order of the Local Government Board is that the small-pox hospital must be some distance away from the other infectious diseases hospital. I know we have been obliged to buy a site over two miles away from the other hospital. I do not think at the present day any one could borrow money with the sanction of the Local Government Board, to erect a small-pox hospital anywhere near another infectious diseases hospital.

Mr. CAMPBELL: Has Mr. Godfrey any statistics showing the diminution of infectious disease since the erection of this hospital in the district. That is an important matter which ought to receive more consideration.

Mr. J. T. EAYRS; I should just like to say I have put up a hospital within the last two months for 20 patients, and have erected it on the same ground as the permanent hospital. It is an iron building costing 600*l.* furnished complete, and we are paying for it out of the rates and not applying to the Local Government Board. That is the solution of the question if you want a hospital. The remarks of Mr. Campbell are a little wide of the mark. We do not go into the medical side of the question or the rate of sickness, but provide what is asked for by the local authority.

Mr. MARSTON: There are very great difficulties in the way of undertaking the collection of ashpit refuse in a large and scattered district, and I should like to ask Mr. Godfrey whether the whole of the cost of removing ashpit refuse is charged upon the rates, or any part upon the occupiers whose ashpits are emptied.

Mr. J. P. NORRINGTON: I notice on page 126 Mr. Godfrey says that by reversing the flow of the liquid the filters are

self-cleansing. I think when Mr. Godfrey replies he might explain the process to us. I assume the first portion of the sewage which passes through the filters after reversing the process is sent back to the sewage tanks again.

Mr. R. Godfrey, in reply to the discussion, said: I thank you for the vote of thanks, though the success of the meeting is sufficient thanks in itself. I think this is almost a record in attendance for any midland counties meeting. I must say I feel it to be a compliment both to the Council and myself. Mr. Pickering spoke as to the work done by the filters; the 27,000 gallons per square yard per day is the maker's claim; I have not sufficient stuff to test them at their full capacity, our sewage does not come to 50,000 gallons per day. We have put down works to suit a population four or five time our present population. The sewage does not go through the filters; it is the effluent after it has been sterilised that goes through the filters. With regard to the treatment, the largest quantity of chemicals we put in is 7 cwt. of lime and 5 cwt. of proto-chloride of iron. On the wall of this room there is a chart showing the proportion of purification obtained. With regard to the question of the provision of a small-pox hospital which Mr. Massie raised, we are in the same position as others. When we applied to the Local Government Board for a loan, they said, "No, you must go and find another piece of land." I said, "We were seven years finding the piece of land we have got now, and if we are to wait another seven years small-pox may decimate us." The authority are now going to put up an iron building and pay for it out of the rates. It is best to put up a temporary building, and then to find the firemen a job to burn it. You don't want to have a building permeated with small-pox. Mr. Willcox asked as to the difference of the Bacillite treatment at Kettering and King's Norton. At Kettering they began treating the crude sewage; that is now changed to treating the effluent only. The sludge is no more offensive here than it was at Kettering, and with a domestic sewage like ours we do not get such a large quantity of sludge. With regard to Duckett's closet we have only introduced them since the great frost of 1895, which compelled us to look for something different from the ordinary plumber's water-closet. One great reason why they have been introduced here, is that in this scheme we have every gallon of sewage to pump, and therefore we endeavour to reduce our flow of sewage to the smallest possible quantity. Mr. Campbell refers to the death rate from zymotic

disease. I must refer him to the doctors and to Table V. in the paper, which gives the death rate for the last fourteen years. The hospital was erected in 1887.

The Members were entertained by Mr. Bayliss, Chairman of the District Council, to refreshments, before proceeding to view the various works and places of interest.

The first stop was called at Highbury, the residence of the Right Hon. Joseph Chamberlain, Secretary of State for the Colonies, who had kindly given permission for the Members to view the pleasure gardens and grounds and the famous orchid houses and conservatory. The opportunity was utilised to take a photographic group of the Members attending the meeting, in a picturesque portion of the grounds.

From Highbury the Members proceeded to the electric generating station of the Birmingham Central Tramway Company. This section of the Central Tramway Company route is worked on the electric accumulator system, the whole of the batteries being charged at this depôt at Bournbrook. The engineers to the Company are Mr. E. Pritchard, C.E., of Birmingham, and Mr. J. Kincaid, who are jointly responsible for the various works, which were executed under the superintendence of Mr. A. W. Pritchard.

The Members were next afforded an opportunity of seeing one of Morrison's road scarifiers at work, a section of a public road being broken up by the machine.

The round of visits was concluded with an inspection of the Sifford Sewage Works, designed and carried out by Mr. Godfrey, and fully described in his paper read earlier in the day. A great deal of interest was taken in an ingenious engineering device by which Mr. Godfrey succeeded in making water-tight a portion of a leaky sewer running under the canal, and which was drawing away the water of the canal company.

On returning to King's Heath the Members were entertained to dinner by the Bacillite Syndicate.

DISTRICT MEETING AT KEW, TWICKENHAM AND HAMPTON.

May 30, 1896.

C. H. Lowe, M. Inst. C.E., Vice-President, *in the Chair.*

A Home Counties District Meeting of the Members of the Association was held at Kew, Twickenham and Hampton on Saturday, May 30. The members assembled at the Richmond Main Drainage Works at Mortlake. The President of the Association, Mr. E. R. S. Escott, M. Inst. C.E., was unfortunately unable to attend the meeting, and in his absence Mr. C. H. Lowe, of Hampstead, Vice-President, presided over the proceedings.

The Vice-President having expressed regret at the unavoidable absence of Mr. Escott, called upon

Mr. Fairley, Engineer in charge of the Richmond Main Sewerage Board Works, who read the following paper.

RICHMOND MAIN SEWERAGE BOARD WORKS, MORTLAKE, S.W.

By WILLIAM FAIRLEY, Assoc. M. Inst. C.E., F.G.S.,
Engineer to the Board.

The district of the Richmond Main Sewerage Board includes six parishes, viz. Richmond, Kew, Petersham, North Sheen, Mortlake and Barnes, having an area of 4983 acres, a resident population of about 45,000, and an assessable value of 344,794*l.*

The Board was constituted by Provisional Order, dated 1887, and consists of twelve members, ten being elected by the constituent authorities, with two ex-officio members.

Sewers.

The Board, in addition to the pumping station, precipitation works, &c., have about five miles of deep-level intercepting sewers.

These sewers are laid at such a level that the sewage of the whole district can be intercepted, and gravitate to the works at Mortlake.

The sewers vary in size from 12 to 40 inches in diameter, and are constructed of brick and cement, stoneware piping and concrete, and where along the river front under the towpath, of cast-iron pipes.

The gradients vary from 1 in 250 to 1 in 1200.

River water can be admitted at several points for the purpose of flushing.

The ventilation is by means of sewer-gas destructors, plain ventilating columns, and gratings in the roadways.

As a great portion of the district is not much above the level of high water in the river, no overflow can relieve the sewers during rain storms at such a time. Overflows have, however, been constructed at two points, and additional overflows are in progress. The usefulness of these overflows is of course limited to the time when the river water is below or about half tide.

Works.

The works at Mortlake are situated close to the River Thames.

The total area of land purchased by the Board was 11 acres. Of this, however, only 8 acres are enclosed, the remainder being in the occupation of a market gardener.

The works include a range of buildings containing all the necessary appliances for pumping sewage, carrying out the necessary operations for chemical precipitation, and for pressing the sludge by means of filter presses.

Cottages are also attached for the employés, together with stables, also dock and wharf for the unloading of goods.

Tanks.

There are eleven precipitation tanks, each 100 feet by 30 feet by 7 feet 6 inches deep from the top of coping, the capacity of the whole being about 1,210,000 gallons; they can be worked either on the intermittent system or with continous flow.

The walls are of Portland cement concrete, faced with blue Staffordshire bricks, the division walls being 2 feet 6 inches thick.

The coping is formed of specially made blue Staffordshire coping 12 inches deep.

In addition to overflow weirs, each tank is fitted with the usual discharge pipe with floating arm. These floating arms are fitted with two outlet pipes, one of which draws the water in the tanks down to a level of about 3 feet below top water-level, and delivers into a channel commanding the high-level filters. The remaining depth of water in the tank being drawn off by a low-level outlet and delivered by a low-level channel to another set of filters.

The tanks are fitted with scum boards fixed at the weirs, and a wrought-iron gangway runs from one end of the tanks to the other, in such a position that the whole of the valves may be worked in stormy weather without risk to the workmen.

Filters.

The effluent water from the tanks can be led on to eight filter beds; four of these are at a high level, and are each 107 feet by 100 feet, formed with Portland cement walls coped with blue Staffordshire coping, the floors being formed with cement concrete 12 inches thick.

The filters have the usual inlets fitted with disc valves, and the filtering material, averaging 3 feet 6 inches in depth, is composed of a layer of 9-inch pipes, followed by gravel and sand of varying fineness, and finished with 3 inches of loam and sown down with grass.

The four low-level filters are constructed in a similar manner, but measure 107 feet by 44 feet 6 inches each, and the filtering material is only 2 feet thick.

The total area of these filters is $1\frac{1}{2}$ acres.

They have been in constant use since the works were opened, and are only now having the surface soil cleaned and renovated.

Process.

The process of precipitation in use consists of first, a small dose of carbolic acid and iron salts is mixed with the sewage as it enters the pump well.

After being pumped up, the sewage receives the addition of a small quantity of milk of lime, approximately 4 or 5 grains per gallon, and afterwards about 7 grains per gallon of a mixture of sulphate of alumina, iron, &c.

The water after leaving the tanks is passed through the high-level or low-level filters and gravitates to the outlet channels, from whence it is discharged on the ebb tide into the river.

At high water the surface of the water in the river is at a considerable height above the level of the water in the filters, and at such times the filtered water gravitates back by two 24-inch pipe drains to a pump well in the main building, from which it is lifted by two direct-acting steam pumps, capable of lifting 4,000,000 gallons in twenty-four hours, into a channel at a sufficient height for it to gravitate to the river.

The expense for chemicals per million gallons varies from time to time from 22*s.* to 25*s.* per million gallons.

Analyses.

	Untreated Sewage.	Effluent.
Free ammonia	0·0475	0·017
Albuminoid ammonia	0·005	0·0012
Oxygen absorbed from standard, $K MnO_4$, acting in the cold for three hours ..	50·2 c.c.	16·2 c.c

Constituents expressed in parts per 1000.

The above are taken from a paper by Professor Adeney, Royal University, Dublin, read before the Institution of Civil Engineers, Ireland; the tests being made on samples taken hourly for twelve hours, and sent to him by the Author.

Pumping Machinery.

The pumping machinery originally provided consisted of three horizontal jet condensing pumping engines, each capable of pumping 4,000,000 gallons in twenty-four hours, the approximate lift being 40 feet.

The following are the chief dimensions.

High pressure cylinders	14 in. diam.
Low „ „	24 „
Stroke	33 „
Air pumps, single-acting	14½ „
„ „ stroke	16 „
Pump plungers	24 „
„ stroke	5 ft.
Displacement per foot	19·539 galls.

They give a mechanical efficiency of about 65 per cent., with a consumption of feed water per I.H.P. of 20·5 lbs. per hour, or 31·5 on the P.H.P.

Within the past two years additional pumping engines have been fixed, with a total capacity of 20,000,000 gallons per day. A new engine room has been built adjacent to the old engine room, and contains a vertical duplex pumping engine on the Worthington principle, capable of pumping about 15,000,000 gallons per day.

The following are the chief dimensions:—

High-pressure cylinders	12 in. diam.
Intermediate-pressure cylinders	17 „
Low-pressure cylinders	28 „
Stroke	36 „
Pump plungers	30 „
Stroke	36 „
Displacement per foot	30·354 galls.
Contract speed	22·87 rev. per min.
Steam pressure (maximum)	80 lbs. per sq. in.
Clear total area through suction valves	3330 sq. in.
„ „ delivery valves	„

The steam valves on this engine are a departure from the usual practice. They are all circular valves, but the high and low-pressure valves are placed in the cylinder covers. The clearance spaces are thus considerably reduced.

This engine is fitted in the pump with hanging flap valves, being the same kind of valves as fitted in the three horizontal pumping engines, with several details improved.

It may be interesting to know that the valves in the main pumps at this station fitted with leather hinges and beats, have been in work for more than five years, practically without any renewal of leather or valve.

The vertical Worthington, on trial runs at a speed of 28½ revolutions per minute, gave a mechanical efficiency of 87·4 per cent., the feed water per I.H.P. being 17 lbs. per hour, or per P.H.P., 19·44 lbs. per hour. This, on such a low lift as 35 feet,

that being the total head against the pumps during the trials, is an exceptionally good result.

The centrifugal pumping engine is one of the ordinary pattern direct-coupled vertical engine and pump.

The delivery from the pump is below the floor, and the suction does not go to the bottom of the well, the pump being intended only to draw 20 feet below the floor in case of storm water rising to that level.

The principal dimensions are:—

Cylinder	11½ in diam.
„ stroke	9 „
Diameter of pump fan	38 „
Revolutions per minute	255–260.
Steam pressure	60 lbs.
Diameter of delivery pipe	15 in.
„ „ suction	„

In 1893 the two auxiliary Worthington pumping engines used for lifting effluent water only, were altered and fitted with double suctions connected to one main suction pipe 21 inches diameter, leading into the sewage well a distance of 126 feet. By this means these two pumps can be used either for pumping effluent or for assisting the main pumps in stormy weather, whenever the water rises to a dangerous level.

From the report published by the Board of the work in 1893–4 the cost of pumping is given as follows:—

	£	s.	d.
Wages	0	11	8
Coal	0	17	0
Waste	0	0	2
Oil	0	0	5
Fluid, &c., boilers	0	0	5
Other expenses	0	0	4
	£1	10	0

The above is for the dry weather flow only, and includes the proportion of the expense of three shifts of men.

Since the new machinery has been fitted the cost has been reduced, more particularly for the pumping of the storm water, the new engine alone being capable of pumping 7,000,000 gallons on 30 cwt. of coal.

The pumping power by the above additions has been increased within the past three years from 12,000,000 to 36,000,000 gallons per day.

Steam is supplied by three Galloway boilers, each 18 feet by 6 feet 6 inches. The flues are on the Livet system, and each boiler is

fitted with a Hotchkiss mechanical boiler cleaner, by means of which the deposit is removed hourly.

Steam Superheater.

A Schwoerer steam superheater has been fitted within the past eighteen months, and no difficulty has been found in getting a superheater of 150° above the temperature of the saturated steam.

Numerous trials have been made on the different engines with saturated and with superheated steam.

With the newest and best engines a gain of approximately 10 per cent. on the P.H.P. has been got, while with the more wasteful type of engine a gain of from 25 to 28 per cent. in the amount of steam used was the result from using steam highly superheated.

Electric Light.

About three years ago the whole of the works were fitted up with electric lighting plant, consisting of dynamo, engine, and 84 lights (all incandescent) varying in power from 8 to 400 C.P.

The generating plant is placed in the main engine room, and consists of an Elwell-Parker dynamo capable of producing 60 amperes at 100 volts, driven by means of a heavy link belt from a vertical engine specially fitted for this work.

The whole of the building is divided into five circuits, each circuit being controlled from a switchboard in the engine room.

The large sewage well below the pump house is fitted with lights in water-tight fittings with special precautions taken for insulation.

This was, the Author believes, the first sewage well of any considerable size and depth lit by the electric light permanently in this manner.

Since the date of its inauguration the installation has run without any trouble and practically without any repairs.

On many occasions during the winter months it has been run continuously for more than 14 hours.

The price per unit to the Board works out as follows:—

	d.
Coal, &c.	1·05
Oil, waste, &c.	·20
Interest, lamps and sundries	·25
	1·50 pence.

Pressing Plant.

Originally three 36-inch sludge presses were erected in the pressing-house, the pressing being done by means of hydraulic forcing engines. The system, however, had very serious disadvantages and the maintenance was extremely heavy.

Recently three additional presses embodying several improvements have been fitted, and the opportunity taken of changing the whole system over from direct pumping to pressing by air pressure, one direct pumping engine, however, being still reserved as a stand-by in case of a breakdown or anything going wrong with the air plant.

The whole of the plant since its erection has worked extremely well, and has fulfilled all the conditions that were required of it the plates having been tested in an unusually severe manner but without any breakages.

The new presses differ materially from those formerly put down. The opening and closing gear is a new pattern.

The plates, the breaking of which were the chief troubles formerly, were designed and specified to overcome the previous difficulties. The specification required a test pressure of 150 lbs. on the one side of the plate only.

All the plates, both new and old, are fitted in the central orifice with a brass clip to secure the cloths. This device obviates any expense or trouble in sewing or preparing the cloths, nothing being necessary beyond punching out a hole in the centre of the canvas the required size.

The clip as first devised was not satisfactory, but by remedying the defects a clip was at last modelled which gives little or no trouble.

The cost of pressing is as follows :—

	s.	d.
Labour	0	10
Lime	0	9
Cloths	0	4
Coal, oil and stores	0	3
	2	2

The above is for ordinary work, but the output can be increased from 25 to 30 per cent. without increasing the total amount paid for labour in the day or week.

Large lantern lights have been fixed on the roof, and the sludge

pit and sludge vats ventilated continuously into the chimney shafts by a steam exhauster worked by the exhaust from the engines.

The outfall to the river has been reconstructed, and is capable of discharging all the water pumped by the pumping machinery at high water.

The whole of the work completed up to 1891 was designed and carried out by J. C. Melliss, Esq., M. Inst. C.E.

Since 1891, the extensions, additions, new pumping and sludge-pressing machinery, &c., have been designed and carried out under the Author's supervision as Engineer to the Board.

The annual amount of expenses for maintenance, repayment of capital and payment of interest is about 14,500*l.*

DISCUSSION.

Mr. Jones: Is all the effluent filtered?

Mr. Fairley: The storm water is not filtered. The system is the separate system throughout, but roof water is admitted to the sewers. The Board made the Barnes district take all their road water out of the sewers, and we hope ultimately to keep all the roof water of new houses out of the sewers.

Mr. Lovegrove: You cannot do that under your existing powers.

Mr. Fairley: No. The Board have been in communication with numerous sanitary authorities to approach the Local Government Board to get a public Act to apply to the Thames valley, so that each authority could adopt it to keep out the roof water, and have the complete separate system if desired. Where you have to pump all the sewage, it is a very important matter.

Colonel Jones: How do you get your sewage so very dilute?

Mr. Fairley: We don't get it very dilute; the solid matter is down below, and does not go over the weirs but under the surface.

Colonel Jones: There must be very careful screening.

Mr. Fairley: Yes, there are three screens, one before pumping and two after.

Colonel Jones: Where do you pump the sludge out?

Mr. Fairley: It all goes through the pressing house: the quantity is from 23 to 26 tons per day of pressed cake.

Mr. Walker: To what extent do you filter?

Mr. Fairley: I think it is all being filtered at present.

In reply to a further question,

Mr. Fairley said: Generally speaking the whole of the water is filtered, but at night and in the early morning, when it is more dilute, it does not require to be filtered. The Thames Conservancy Board have a standard, and at no time since the work commenced has there been any complaint.

Mr. T. Walker: How often have you to take the settling out of your tanks?

Mr. Fairley: Two or three times in a fortnight. It varies according to the weather.

Mr. Walker: That is the stuff that is pressed from the bottom of the settling tanks.

Mr. Fairley: There has been nothing done at the filters for five years until the present season, when we took off the top layer and put in some fresh soil.

Mr. Walker: How do you get out the solids?

Mr. Fairley: We sweep it into the sludge tank, and from the tank it is pumped up to vats at the level of the pressing house.

Mr. Walker: What is the depth of the filtering material, and is it clean?

Mr. Fairley: From 16 inches to 2 feet, and as clean as a water-works filter.

Mr. Silcock: Do you work some of the filters on the continuous system and some on the intermittent system? And which do you prefer?

Mr. Fairley: If you want a very clear effluent it is better to run intermittently.

A Member: What is the practice in the contributory district?

Mr. Fairley: They separate the whole of the rain water on the streets and roads from the sewage.

Mr. Lovegrove: Has Richmond adopted the separate system throughout? Do they have a double system of drains for each house?

Mr. Fairley: I do not know the practice in the surveyors' offices of the different constituent authorities.

Mr. Lovegrove: We should like the proportion of sludge to sewage, and the cost.

Mr. Fairley: The proportion is about, say 8 tons of pressed sludge per million gallons. The price for pressing is from 2*s.* to

2*s.* 3*d.* per ton ; and the barging another 2*s.* The cost of barging is from 500*l.* to 600*l.* per annum.

Mr. SILCOCK: Cannot you dispose of the sludge?

Mr. FAIRLEY: Not in London. At the present time the Board have a scheme under consideration for enlarging the works, and if carried they propose to burn the house refuse from the six parishes and the sludge together.

In reply to a question, Mr. Fairley said the furnaces proposed would be similar to those Mr. Dawson was erecting at Leyton.

Mr. W. H. SAVAGE said: The quantity of sewage seems to be equal to 50 or 60 gallons per head daily.

Mr. FAIRLEY: It works out at 45 gallons per head per day. The population during the summer was more than 45,000.

A MEMBER: How are the sewers ventilated?

Mr. FAIRLEY: By Shaft's gas destructors, and open gratings in the roadways.

A MEMBER: Are the gratings all open?

Mr. FAIRLEY: The only open gratings are in the roadways which you may call rural. In the streets they are fitted with shaft ventilators. The gas destructors we have to maintain under the award of an arbitration.

A MEMBER: Do the furnaces keep alight?

Mr. FAIRLEY: I believe they do.

Mr. LOVEGROVE: What is the cost per year?

Mr. FAIRLEY: 8*l.* or 9*l.* per column. But we must maintain gas destructors where the award requires them on the river front. We use Holman's old pattern.

Mr. C. JONES proposed a hearty vote of thanks to Mr. Fairley for his paper descriptive of the works.

Mr. T. WALKER seconded the vote of thanks. He said, We are much indebted to Mr. Fairley for the opportunity which he has given us of seeing the works.

The vote of thanks was unanimously accorded.

The Members then inspected the various works described in the paper, and were afforded an opportunity of seeing one of the sludge presses actually at work. From the Richmond works the Members drove to Twickenham, where another opportunity was given for the inspection of sewage disposal works. At Twickenham Mr. G. B. Laffan, Engineer to the District Council, gave the following description of the works.

Twickenham Sewage Works.

The Twickenham Sewage Disposal Works were among the first constructed in the valley of the Thames, and consequently did not have the opportunity of profiting by the experience of similar works; but even at the present time they will bear favourable comparison with many of the more recent works. I have not asked you to come here because I have anything novel or interesting to show you, but I thought as it was on our way to Hampton we might break the journey here with some little interest. The scheme of sewage disposal adopted here is, I think, a good one, but it was rather badly carried out. The whole of the parish, consisting of 245 acres, with a population of 17,000 or 18,000, is drained to these works by gravitation. The sewage is received into these low-level tanks some 30 feet below where we are standing. It passes from these tanks through coke screens into a passage leading to the pump wells. The sludge left behind in the tanks is discharged into a well at a still greater depth by means of pipes with plug valves from the bottoms of the tanks. There are penstocks at each end of the tanks, and one of the four tanks is emptied every week, the tank cleaned out, and the sludge discharged into the sludge well. We have a chain pump, worked by a separate engine, which lifts the sludge some 70 feet, and it then flows through the shoots you see to the pits made on the adjoining land. The liquid sewage is lifted some 55 feet by means of two 25 and one 40-H.P. horizontal engine. It then flows through the concrete carriers erected above the ground level on arches to the high-level settling tanks. It is treated on its way with alumino-ferric at the rate of about 2 grains to the gallon. The chemical is simply placed, in the form of cakes, in the carrier, and is allowed to dissolve therein, about $2\frac{1}{2}$ cwt. being used per day in this way. The sewage then is allowed to rest for some five or six hours in the high-level tanks, and is thence discharged over these filters. The sludge from the tanks is discharged, by means of shoots on the adjoining land, into pits similar to those provided for the sewage from the bottom tanks. We have eight high-level tanks, and fill and empty several every day, depending, of course, on the quantity of sewage. Our usual summer flow is about 750,000 gallons, but in winter we have double this quantity. We work on the separate system throughout the whole district, having a com-

plete separation of drains discharging direct into the River Thames to take all the surface water from roofs of houses, yards, roads, &c. Every possible effort is made to exclude the surface water from the sewers which discharge into these works. We insist on separate drains for every house, taking only the sewage from water-closets, bath wastes and sinks into our sewers, and all other drainage by means of separate pipes into our surface-water system. We have no difficulty in carrying this out, and all owners and builders freely comply with this arrangement. We have four filters, two being constantly at work, one cleaning out and the other at rest; sometimes three are required, but two usually do the work. The filters consist of coke, shingle and sand, through which the sewage passes several times by means of upwards and downwards intermittent filtration and exposure in thin layers to the atmosphere. We find this exposure very beneficial, and I have recently made alterations in the filters, which have the effect of making this exposure more extensive. From the filters the effluent passes to a culvert which discharges into the Thames about a mile from the works. Formerly the effluent discharged into the river Colne, which flows past the works, and it was originally intended to discharge it direct into this stream, but that has been abandoned, and I have constructed this culvert right away to the Thames. Samples of our effluent are taken at regular intervals by the Thames Conservancy, and on all occasions give them perfect satisfaction. In fact, they inform us that our effluent is the best in the Thames valley; but I believe they make the same complimentary statement to many of the other works. We have very favourable terms for the disposal of our sludge, as we are here surrounded with market gardens, and the occupier of these gardens takes the whole of our sludge and uses it on his land. We make him an annual payment for doing so, but we are saved all cost of pressing and other expense usual in connection with the disposal of sludge. There is one important consideration in this matter to which I would like to call your attention, and that is that we use no lime with our sewage, and this, in my opinion makes the sludge far more valuable for agricultural purposes.

The works were thoroughly inspected by the Members, Mr. Laffan acting as guide and pointing out the various matters of interest. From Twickenham the journey was continued by way of Bushey Park to the Grand Junction Company's works, and the Southwark and Vauxhall Water Company's reservoirs. On arrival at the

waterworks the Members were entertained at luncheon by Messrs. Aird & Sons in a marquee erected in the grounds. Mr. Ellis, of Messrs. Aird & Sons, presided after luncheon.

Mr. Lowe, Vice-President, proposed the health of Messrs. Aird & Sons, coupling with the toast the name of Mr. Ellis.

The toast having been heartily honoured,

Mr. Ellis briefly responded, and expressed his personal pleasure at meeting the Members of the Association.

The Members then inspected the various works which were in progress. The first was the Sunnyside storage reservoir of the Southwark and Vauxhall Water Company, which has recently been constructed by Messrs. Aird & Sons, and has a capacity of 90,000,000 gallons, with a total depth of 36 feet of water. The top water level is 21 feet above the ordinary summer level of the river, the water being raised by centrifugal pumps driven direct by high-speed single-acting triple-expansion engines, which are supplied with steam by four Babcock and Wilcox boilers working at a pressure of 200 lbs. per square inch. The bottom of the reservoir is some distance below the surface of the London clay, and the structure is kept water-tight by a puddle wall carried all round the embankments from top bank level down to 3 feet into the clay. The inner slopes and bottom are lined with 9 inches of cement concrete, the upper portion of the slopes being further protected by brick-on-edge paving set in cement. Provision is made for drawing off at different levels, or decanting the water, by means of a cast-iron valve shaft having the necessary sluice valves.

The next object of interest was the "Stain Hill" storage reservoirs of the same water company, in course of construction by Messrs. T. Aird & Sons. This reservoir is divided into two by means of a central embankment common to both, and will, when finished, contain 300,000,000 gallons, having a total depth of water of 40 feet, and a top water level of 37 feet above ordinary summer river level. These will also be filled by the pumping engines above referred to. The puddle trenches have been completed to ground level, and some portion of the excavation of the body of the reservoirs could be seen in progress, together with the formation of the earth embankments, which are being made in 8-inch layers well watered and punned to thoroughly consolidate them.

The form of construction of these reservoirs is practically the

same as the "Sunnyside" reservoir, only the bottom and the lower portion of the slopes of these will not be lined with concrete. A similar arrangement for decanting the water is intended. The object is to draw water from these storage reservoirs for the daily supply instead of from the river in the time of flood.

From here the Members were conducted to the works of the Grand Junction Water Company, where the "Reidler" and "Worthington" pumping engines were seen at work.

The Grand Junction Company's Works.

The whole of the water pumped by the company, amounting to about 20,000,000 gallons per day, is obtained from the river at Hampton. The intakes are provided with screens and sluices for straining and controlling the water. A portion of the company's district is supplied from Hampton, for which purpose there is a complete system of filters and pumps, but the most important—viz. the town district, is supplied from the Kew Bridge station. Powerful engines of the horizontal compound tandem type are used for supplying the Kew Bridge station from the Hampton station. A system of preliminary filters is in use at Hampton for this portion of the company's district, the water being, as a rule, passed through two sets of filters (one at Hampton and the final at Kew Bridge) before it is pumped into the district.

The following are the approximate capacities of the pumping engines:—

	Capacity for Twenty-four Hours.
Two rotative compound engines, by Boulton & Watt, 1882	8,000,000
One diagonal compound engine, by Hawthorne Davey, 1889	4,000,000
Two direct-acting Cornish engines, by Harvey & Co., 1860	18,000,000
Two horizontal compound tandem, coupled, by J. Simpson & Co., 1891 (high lift)	14,000,000
Two horizontal compound tandem, coupled, by J. Simpson & Co., 1891 (low lift)	14,000,000
One triple Worthington, J. Simpson & Co.	3,000,000
One centrifugal, J. Simpson & Co.	11,000,000
Two horizontal cylinder, with three-throw vertical pumps, Boulton & Watt	7,000,000

This station contains about 9 acres of preliminary filters and about 4 acres of filters for the country district, besides one storage reservoir containing about 45,000,000 gallons.

The West Middlesex Waterworks Company.

The West Middlesex Water Company have at Hampton only an intake and pumping station, the water taken from the river being merely passed through screens and pumped for treatment to the subsiding reservoirs and filters at Barnes, about 10 miles distant. The plant at the Hampton station consists of a horizontal high-duty Worthington pumping engine, capable of delivering 24,000,000 gallons per day to the Barnes reservoirs, and two high-duty vertical Worthington pumping engines, each having a capacity of 16,000,000 gallons per day. Steam is supplied to these engines from five Cornish boilers and three Lancashire boilers.

The Southwark and Vauxhall Company's Pumping Engines.

After leaving the West Middlesex works the Association had an opportunity of viewing the direct-acting rotative pumping engines of the Southwark and Vauxhall Water Company. These engines are in two pairs ranged side by side, and are compound surface condensing, having cylinders of 32 inches and $52\frac{5}{8}$ by 7 feet stroke. They pump against a head of 280 feet, and deliver filtered water direct on to the company's district through a 30-inch main, and also to the service reservoirs at Nunhead through a 42-inch main. Their combined capacity is 20,000,000 gallons in twenty-four hours. They are steamed by six Lancashire boilers, 7 feet 6 inches in diameter by 28 feet long, having corrugated flues, and work at a pressure of 100 lbs. per square inch. In a house adjoining were seen a pair of Cornish beam engines at work, having 80-inch cylinders, 10 feet stroke, and double-acting pumps $24\frac{3}{4}$ inches in diameter by 10 feet stroke, these pumps filtering water against a head of 240 feet through a 30-inch main on to the district, and each has a capacity of 5,000,000 gallons per twenty-four hours. These engines are supplied with steam by eleven Cornish boilers working at a pressure of 40 lbs. per square inch.

DISTRICT MEETING AT HANLEY.

June 13, 1896.

Held at the Town Hall, Hanley.

E. R. S. Escott, M. Inst. C.E., President, *in the Chair.*

A Midland Counties District Meeting of the Association was held at Hanley on Saturday, June 13. The Members who arrived in Hanley on the Friday evening were given an opportunity to inspect the Corporation electrical works, and the installation of the light in the public buildings and the streets of the town. Mr. Lobley, the Borough Engineer, who has charge of the electrical works, with Messrs. Cowell and Sutherland, the Electrical Engineers, received the Members at the works, and fully explained the system of lighting adopted. Subsequently a tour was made of Hanley, the Victoria Hall, the Public Library and other buildings being visited.

On Saturday morning the Members of the Association met in the stipendiary court room at the Town Hall. Mr. E. R. S. Escott, M. Inst. C.E., Halifax, President, occupied the chair.

The Mayor (Mr. Councillor Tunnicliffe), in receiving the Members, said: Gentlemen, I am sure I give you a very hearty welcome to Hanley. You will have an opportunity, under the guidance of Mr. Lobley, of seeing the improvements which Hanley has made since the Association was last here; among which I may mention the park and the electric light installation. I think, on the whole, considering the size of the town, we have kept abreast of the times. I once again welcome you here very heartily.

The President said: Gentlemen, I have, on behalf of the Association, to thank the Mayor for his kind remarks and for his welcome to Hanley. We have a long programme before us, but under the guidance of Mr. Lobley we look forward to a very

pleasant day. I, on behalf of the Association, thank the Mayor and the other members of the Corporation who have favoured us with their presence this morning.

Mr. A. T. Davis, Honorary Secretary for the Midland Counties District, said: I have received through Mr. Lobley letters of regret from Mr. Cartwright, Bury, Mr. May, of Brighton, the President Elect, Mr. Lewis Angell, of West Ham, Mr. A. M. Fowler, Mr. E. Pritchard and Mr. Bradley.

Mr. Lobley then read the following paper—

SOME OF THE PUBLIC WORKS CARRIED OUT IN HANLEY DURING THE PAST TEN YEARS.

By JOSEPH LOBLEY, M. Inst. C.E., Borough Engineer and Surveyor, Hanley.

It is not the intention of the Author to attempt a complete statistical record of the ordinary routine of the borough engineer's department, but simply to give a short description of some of the principal works carried out since the Annual Meeting of this Association held in Hanley in July 1886.

Sewage Works.

In May 1881 a district meeting of this Association was held in Hanley, and a paper was read by the Author on the Hanley Sewage Works, which had then recently been opened. Members are referred to vol. vii. p. 58, for this description, and it will only be necessary now to shortly describe the extended works carried out since that date.

An additional precipitation tank measuring 200 feet by 100 has been constructed. About 19 acres of land has been purchased, extending the property of the corporation close up to the boundary of the borough along the valley of the Trent near Stoke station. This land is reserved for filtration areas. Four sludge presses, with air compressor and circular sludge tank and other appurtenances, together with the new buildings required, have been erected. Plans have been approved by the Local Government Board, and the work will be shortly taken in hand for dealing

with the small outlying districts which are below the level of the existing intercepting sewers. It is proposed to lay down the Shone system for these districts, which although small, are a considerable distance from each other, extending from a mile to the south-east to a mile to the north-west.

An additional air compressor will be erected at the sewage works and will probably be driven by electricity, thus affording some work for the electric light engines and boilers during the daytime and after midnight.

Since the beginning of May, the consent of the Town Council having been given to the experiment, the Bacillite Sewage Purification Syndicate have had arrangements in progress for dealing with the sewage. At the present moment it cannot be known positively whether sufficient work will have been done to enable the Members to form any opinion on the merits of this system.

Hanley Town Hall.

When the Annual Meeting took place in 1886, the Members then present were able to see the alterations effected in the front part of the building to adapt it for municipal purposes, also the new police cells. The new Quarter Sessions Court was then in course of erection. In 1887 the Author was instructed by the council to prepare plans for an assembly room to be built upon what was then the bowling green, together with accommodation for the School Board Offices. His instructions were (1) to erect as large a hall as the site would permit; (2) the room to be good acoustically for music or public speaking; (3) the cost not to exceed 8000*l.*

This was a problem that had rarely been faced, but the Members will be able to see the result. The building has been erected and furnished for 10,000*l.* complete. The external appearance is designed in keeping with the remainder of the building.

The hall will accommodate 3000 persons, including promenade standing room. For political meetings or other large gatherings, by removing the chairs from the ground floor, over 5000 people have been present at one time.

Very little has been attempted as regards decoration, that being left to be dealt with in the future. The ceiling is elliptical in section, but part of the roof timbers and tie-beams come down below and are visible.

Until the design is fully carried out as regards decoration, these timbers certainly do not present a very good appearance. The object, however, of their existence, in lieu of any other form of roof and ceiling, has been obtained, as the acoustical properties of the hall when filled, both as regards music and public speaking, have given general satisfaction.

The Author's plans were submitted specially on this point to Professor T. Roger Smith and received his approval, with a report that the proportions of the room were likely to produce good acoustical results.

1887 being the year of the Queen's Jubilee, the title "Victoria Hall" was given to the building, the foundation stone being then laid; but it is really the Town Hall in the same sense as the Birmingham Town Hall, namely, the place of public assembly, and is part and parcel of the Town Hall or Municipal Buildings.

The Committee has decided this season to paint and clean the ceiling of the Hall and the corridors of the Town Hall, considerably the worse through undermining and electric wiring, but unfortunately this will not be done in time for the district meeting.

Subscriptions were raised to commemorate the Queen's Jubilee, the proceeds of which were appropriated to several objects, including the new organ in the Victoria Hall, grants to the School of Art, memorial medals, and a dinner to 2300 old people.

Mr. George Meakin generously contributed one-third of the amount of the subscription list, and for this reason the organ is generally associated with his name.

He further provided a sum of money to establish popular concerts at very low prices of admission. These go by the name of the Meakin Concerts, and are very extensively patronised during the winter half year, six or seven concerts being then given. In addition to these, other concerts and entertainments are continually taking place, and generally speaking the Hall is very much in use.

The North Staffordshire Musical Festival hold their triennial concerts here, the next taking place in the October of this year.

Free Library.

The late borough offices have been converted into the Free Library. This work was in progress at the Annual Meeting in 1886. Since then the cellar under the reading room has been

deepened, tiled and furnished as a boys' reading room, the ex-Mayor (Mr. Alderman Hammersley) taking a great interest in the work.

The museum is located in the former large room of the Mechanics' Institution. It was commenced as the North Staffordshire Technical Museum, but failed to be self-supporting, and has been since taken over by the Corporation, the admission being free.

The Higher Grade School.

This building, which the Members will have the opportunity of seeing, has been carried out from designs by Messrs. Scrivener & Sons, Architects, Hanley, and is considered well adapted to the purpose of higher education.

Butchers' Market.

A new stone front, together with an entire new roof, has been constructed for this market. The back yard, which was enclosed by a wall and other outlying buildings, being removed and thrown open to the street.

Hanley Park.

At the time of the Annual Meeting here, Hanley had no park, indeed no sign existed that there was likely to be one within a measurable time. The movement to secure land for a park before all available and accessible areas were built upon began in 1890, and rapidly found favour.

The proposition to purchase land for a park on the southern half of the borough was accepted at a large meeting of ratepayers, coupled, however, with the understanding that the north-eastern and north-western parts were also to be provided with smaller parks.

The park at present in course of formation consists of 104 acres, 24 of which is left as a fringe outside the park, and is offered for sale for building residences. A portion of this land on the north side has been recently sold and has realised good prices, the amount obtained being over 8000*l.*

The site is the whole of the open area of land lying between the Hanley built up areas and Stoke station.

No other area of equal capacity was available without going a

long distance, and most probably outside the borough. The Council judged it better to have the park practically in the midst of the people, and thus save it from being covered with houses and streets.

Doubtless there are some disadvantages; trees, shrubs and flowers cannot be expected to flourish quite so well, and the sight of the smoke is to be regretted.

On the other hand, the close proximity of a park, merely as an open space, to the residents of a manufacturing town must be regarded as a great boon, and the expense entailed has been ungrudgingly incurred.

No large landowner or titled neighbour is at hand to make Hanley a present of a park or two, as many other towns are fortunate enough to possess, and land has had to be bought for all three parks, at an average price of 500*l.* per acre.

To the cost of laying out, the late Mr. George Meakin gave 5000*l.*, Mr. Councillor Huntbach, Mayor 1889–92, gave 1000*l.*, and many gifts of money and objects from a large list of donors have also been received. Mr. Alderman Hammersley, Mayor 1892–95, has given the fountain in the Cauldon grounds, or first section of the park. The cost of the park remaining a charge on the ratepayers will be over 70,000*l.*

The area of land acquired by the corporation for the park is divided broadly into four parts.

The Cauldon canal divides the property by an irregular line running east and west, and Victoria Road further divides it by a nearly straight line running north and south.

The Regent Gate on the north is within half a mile from the Town Hall, and Queen's Gate is within a quarter of a mile from the populous district of Broad Street.

Prince's Gate is approached by a tree-bordered avenue 250 yards long and 20 yards wide, which brings the main park into sight, and commodious access from the main road passing through the borough and along which the tramway is laid.

Boughey Road Gate, at the south-east, affords access to the park for the rapidly increasing population of the district lying between this point and the borough boundary, adjoining the North Stafford Hotel at Stoke station.

The Park Roads, north and south, and Avenue Road, afford access to the belt of building land on the one side and to the park on the other.

Victoria Road has now been opened through into Stoke Station Road, nearly at the point where the boundary of the borough cuts across the railway station.

In connection with the park, four new canal bridges have been required. No. 1, or Victoria Road bridge, is 45 feet in clear width of roadway and footpaths; No. 2 is a footbridge; and No. 3 is a carriage-drive bridge, both within the park; No. 4 is the outer road bridge on the eastern side, and is 36 feet clear width, the span being 33 feet clear.

This general description has so far referred to arrangements exterior to the park proper, such plan having been prepared by the author before the appointment of a landscape gardener.

The following more particularly refers to the design within the park fences, prepared by Mr. T. H. Mawson, Park Architect, of Windermere.

The pavilion is placed near the centre of the upper ground, on an elevated position, commanding extensive views in all directions.

The drive from the Regent and Queen's Gates passes the south front of the pavilion on the way to the bridge over the canal; then turning westward by a large curve, it passes by a bridge over an arm of the lake and on to Prince's Gate. Branch drives connect with Boughey Road Gate.

Between the pavilion and the canal the ground is laid out in terraces and garden plots, with flights of steps, to a band-stand and foot-bridge over the canal, extending to the bowling green in the lower ground.

In the same line from the pavilion the walk is continued below the lawn to a fountain, and by flights of steps to the lake boat landing.

Playgrounds are being formed adjoining Victoria Road, the canal dividing that provided for girls from that for the use of boys.

The lake is about 5 acres in extent, and together with the ravine or dingle has been excavated and formed out of practically level ground.

The ground between Stoke Road and Victoria Road is laid out as a public garden, and connects the cemetery with the larger portions of the park, free from the intervention of any buildings. This is called the first section, and with the conservatory, greenhouses and lodge was formally opened in July 1894.

Those previously acquainted with this area, with its plain uninteresting fields interspersed with pit shafts, will admit that Mr. Mawson in designing and laying out the park has had a difficult task to do, and that he has succeeded in his work in a marked degree. It will be remembered that at the last annual meeting at Halifax, Mr. Mawson read a paper on park and garden architecture. Those who wish to enter into fuller detail will find it well described and illustrated in a little book written by Mr. Mawson and published by Messrs. Allbut and Daniel, Hanley, at one shilling.

Hanley Electricity Works.

A Provisional Order was obtained in 1891, enabling the corporation to lay down mains and erect buildings and plant for the supply of electrical energy within the borough.

The Author visited America in the autumn of that year, and made special visits to the electric lighting stations in towns of about the same size as Hanley, in order to make himself acquainted with the general business engineering arrangements required. It will be remembered that at that time there were very few examples of that description in this country.

The designing and carrying out of the buildings, lines of mains, erection of generating plant, and all works in connection therewith, has from the first been entrusted to the Author.

In September 1892, the Council entered into a contract with the Brush Electrical Engineering Company for the boilers, engines, dynamos, mains and sub-station transformers requisite to deal with the compulsory area lighting, both public and private, in its first stages; the system adopted being that known as high-pressure alternating current, with transformers at sub-stations, from which low-pressure distributing mains are laid to consumers' premises. The reasons that influenced the Council in selecting this system as against a continuous-current scheme, as being more suitable for a district like Hanley, were principally:—

1. The works could be placed away from the centre of the town, and where land is less valuable, and where, consequently, extensions could be more readily made as required.

2. The north-eastern corner of the park estate, adjoining the canal, was available as the site for the electricity works, and will be found to be very conveniently situated and but little removed from

the actual centre of the area of supply. Further advantages accrue from its proximity to the canal, for the supply of coal and water for condensing engines.

The high-pressure mains are concentrically arranged in one cable with insulating material between the two sets of copper strands, the whole being insulated and protected by outer coverings. This cable is drawn into cast-iron pipes, forming a ring main from the works, *viâ* Bethesda Street and Piccadilly and the Market Square, and returning *viâ* Tontine Street and Lichfield Street.

The low-pressure distribution mains are not concentric, but are laid double in cast-iron troughs, afterwards filled up solid with pure bitumen. The capacity of these mains is practically increased to any extent desired by reducing the area served by them. This is done by adding transformer stations at the points of most demand.

Public Street Lighting.

(*Within or adjacent to the compulsory area.*)

The contract includes provision for 30 arc lamps of 1200 N.C.P. each, i.e. 400 watts. These are arranged in series, supplied with electricity by a special cable from a continuous-current dynamo. A second engine and dynamo is provided as reserve.

Incandescent Lamps for Side Street Lighting.

Within and adjacent to the district through which the electric light mains pass are other existing gas lamps, in addition to the 53 lamps of various sizes that were dispensed with by the establishment of the 30 arc lamps.

At present it is generally conceded that arc lamps should be used for leading thoroughfares, but there are many positions, particularly in side streets, where the establishment of such a lamp is out of the question, and where an ordinary gas burner or a 60-watt (16 C.P.) glow-lamp would suffice.

There has been laid in the same cast-iron trough with the general supply mains, two separate insulated cables of small size, the whole being afterwards filled up as before described with bitumen.

The Author has devised an arrangement for lighting incandescent lamps in parallel without sending round the lamplighter.

Where arc lamps exist in series controlled from the central station and have independent continuous-current plant and cables, the arrangement is as follows:—

The arc lamp cable is passed through the apparatus (which is placed at sub-stations) and whenever the arc-lamp current is turned on, the apparatus switches on the current from the general supply low-pressure mains to the incandescent lamps arranged in parallel. These should not exceed twenty 16 C.P. lamps off one connection, so that the distance of the furthest lamp should not exceed 200 yards. When the arc lamps are turned out the apparatus switches off the current supplying the incandescent lamps, which are thus automatically lighted and extinguished by closing or opening the arc light circuit at the electricity works.

The apparatus consists of a solenoid or electro-magnet operating a lever; the current of the arc lamps energises the solenoid or electro-magnet, lifts the lever, and by a mercurial or other switch, closes a low-pressure circuit for the incandescent lamps.

The Author believes that incandescent lamps in parallel for street lighting has not received the attention the method deserves. He has seen many complicated arrangements of lamps in series. There are now in operation several lamps arranged as above and working satisfactorily. No switches of any kind or "cut-in" arrangements are requisite at the lamp post.

Within half a mile of the works it is proposed to try a modification of this system devised by Mr. Sutherland. In the new roads round the park, the special cables will be supplied with current at 300 volts, switched on when required at the works; in each lamp-post three lamps, 8 C.P. and 100 volts each, will be placed in series, the group of three being in parallel off the special mains. The cable used is twin lead-covered equal to 7–20 S.W.G., and even if series lighting was used it would not be advisable to use a smaller conductor than that.

The first loans sanctioned were as follows:—

Electricity works, buildings, generating plant, mains, &c., for dealing with the compulsory area of 35 acres in the centre of the town, 21,000*l.*; meters, &c., 1000*l.*; wiring corporation buildings 3000*l.*

Current was first supplied in April 1894, and the works formally opened in the following July. The plant and mains were capable

of supplying 10,000 8-C.P. lamps, and before the end of that year the demand had exceeded the safe limit, and rendered it imperative to extend the works and mains.

Additional sanctions were obtained amounting to 24,000*l.*, the capacity of the works both for public and private lighting being doubled, and the mains commanding an area of 400 acres.

Supply can be given to all applicants along the entire length ($1\frac{3}{4}$ mile) of the main road through the borough, from Stoke Station on the south to the Burslem borough boundary on the north.

The generating plant first erected was as follows:—

Three Lancashire boilers, each 28 feet by 7 feet, working pressure 120 lbs. per square inch; four vertical compound condensing engines, namely, two 200, and two 100 indicated horse-power; four alternating-current dynamos, namely, two 100, and two 50 kilowatts, each driven from engines by ropes; separate compound engine for air and circulating pump and surface condenser; two dynamos for street arc lighting, driven from two vertical compound steam engines of 30 indicated horse-power each; two 10-kilowatt continuous-current exciters driven by belts, each from one of the 50-kilowatt alternators.

The plant erected for the extensions consists of one 300-kilowatt Ferranti flywheel alternator with exciter; one new exciter to each of the former 100-kilowatt alternators, thus providing each alternator in the station with its own exciter; one combined plant for air and circulating pump, surface condenser and boiler feeders, by Messrs. W. H. Allen & Co.; 30 arc lamps and posts, by Messrs. Crompton & Co.; two Ferranti rectifiers capable of dealing with each of the two circuits of 30 arc lamps, the former arc dynamos being held in reserve; new switch-board, by Messrs. Ferranti.

The electric light mains for the extensions consist of paper insulated concentric conductors, lead-covered and laid in troughs, afterwards filled up solid with resin compound; all supplied by the British Insulated Wire Co.

The engine house is furnished with a 7-ton travelling crane, and the boilers with Cass's mechanical stokers driven by separate engine, and two water storage cisterns.

A platform extends in front of the boilers at a level above their tops, so that coal can be discharged into the hoppers of the stokers with the least amount of manual labour.

An arrangement for lifting the coal out of a canal boat or coal shed, and depositing it on the platform, has been devised by the

Author and carried out by the Temperley Transporter Co., who supplied their speciality; Messrs. J. Warner & Sons, of Hanley, supplying the platform traveller, and Messrs. Bergtheil and Young the alternating-current motor.

The Author believes that it will meet the requirements of the electricity works better than the usual form of elevators, which are no doubt well fitted for places requiring steady constant duty. Further the transporter can be used for lifting the coal out of a boat and depositing it in the coal store sheds, or for unloading paving or other material from canal boat to cart.

In carrying out the works the Author has been ably assisted by Mr. G. H. Cottam, the Corporation Electrical Engineer, who had the running of the works in his charge until he received the appointment of Chief Electrical Engineer to the Hampstead Vestry, and also by Mr. C. A. Cowell and Mr. C. J. Sutherland, who were appointed, last September, Electrical Engineers and Joint Managers under the general direction of the Author.

Regarding the financial aspect of the undertaking, the ratepayers have every reason to be satisfied with the prospects.

Not only did the works conclude the first completed year on December 31, 1895, with a balance in hand after paying all expenses, including interest and redemption of loans, but on December 31, 1894, with practically less than six months' running, there was a favourable balance, after discharging all obligations, including a whole year's interest on loans.

The price charged per unit is 5*d.*, current for motive power is offered at 3*d.*, and to churches, &c., for Sundays, at 4*d.*

The Town Hall, Baths, Free Library, Museum, General Market, Fish Market, Butchers' Market, School of Art, Higher Grade School, St. Mark's Church, and the Public Clocks at the Old Town Hall and Shelton Church are lighted throughout by electricity.

Street Improvements.

This paper is already too long, so the Author will refer to one only of those carried out since the Association last met in Hanley.

During the last ten years, opportunity has been taken from time to time to widen the main road between Hanley and Stoke. From Piccadilly to Stoke Station Road, a length of more than one mile, less than a quarter of a mile remains to be dealt with.

When the Author urged the exercise of the ordinary powers of the council whenever new buildings were required, there were few who did not believe the attainment of the object would be far beyond their time.

Messrs. Brown, Westhead, Moore & Co. gave the land between the Park and Canal Bridge required to widen Stoke Road from 41 feet to 55 feet.

The Author wishes to show by this illustration that the prospect apparently of a long period should not deter municipal engineers from venturing to recommend the widening of important roads or the formation of new ones. He has seen more than one agreement to give up land at the end of twenty years come to be realised.

Members who are interested in local particulars respecting Hanley are referred to the Author's Presidential Address in 1886.

Mr. Lobley added to the paper the following remarks illustrative of the varied duties which have to be discharged by a borough engineer. One of my recent duties consisted in rearranging the wards of the borough. There were originally three wards. The town has been divided, not that each ward should represent a separate locality, but that each ward should have a portion of the centre of the town and a portion of the outer boundary, with the roads, generally speaking, connecting the centre with the suburbs. The plan represented a circle divided into sectors, and each ward had interests in the central parts as well as in the outskirts up to the borough boundary.

DISCUSSION.

The PRESIDENT: I think we might style this a very interesting paper, and considering that Mr. Lobley has been in Hanley so long, it is interesting to hear and read what has been done here. I have never had the pleasure of being in Hanley before to-day, but it certainly looks an enterprising town. It is an advantage to Hanley to have a gentleman like Mr. Lobley, who seems to have the technical knowledge and experience of every department. Some of us representing larger populations find our work run in a certain routine, such as sewage disposal or tramways. Here Mr. Lobley goes in for electricity and for laying out parks. These

are things which do not come under the direction of every borough engineer. The paper seems to give full information on every subject but tramways. There is no allusion to the Hanley tramways. I can hardly say I admire the tramcar which brought me from Stoke this morning. I shall be glad to hear any remarks you wish to make on the paper.

Mr. Lobley: I hoped we should have been in the midst of taking up the tram line and relaying it. Last year the company began this work and relaid a considerable portion of the line through the borough for an electric tramway; but for some reason there has been great delay in recommencing. The Provisional Order has passed the Board of Trade. I ask the Members not to pay attention to the not very creditable state of the tramway track. We have deferred the work of repaving the roadway and footpaths until the Tramway Company have relaid their track. The system to be adopted will no doubt be the overhead electric trolley. That portion of the line which has been relaid has a return wire under the sets for that system. I may say I had a scheme under consideration for utilising in the daytime the spare energy we have in boilers and engines at our Electric Light Works; but unfortunately we do not consist of one town like Halifax, with the country all round, or Huddersfield, which has its own tramways. We are a number of towns, like beads on a string, and the tramway runs through from Longton to Fenton, Stoke, Hanley and Burslem. There is a difficulty in getting the towns united for any object, and they took fright when it was suggested that Hanley was going to supply the current, and it soon had to be dropped. There were other difficulties—probably financial ones. The Tramway Company considered they would be better with their own independent source of supply for electricity.

Mr. H. Percy Boulnois said: I have very great pleasure in moving a very hearty vote of thanks to Mr. Lobley for his paper, and for arranging this meeting in conjunction with the District Secretary. I had the good fortune to be one of the few who last night accompanied Mr. Lobley to see some of his works, and consequently I am perhaps able to say what others are unable to say at present. I agree with you, Mr. President, that this paper shows us distinctly the multifarious duties which a borough engineer has to perform. In this paper we have mention made of architecture, sewage disposal, electricity, each one a speciality of itself, and from what I have seen of Mr. Lobley's work I can

heartily congratulate him and Hanley upon the way in which he has carried out this difficult and arduous work. I am obliged, unfortunately, to criticise one little matter which he himself criticises in his paper, that is the ceiling of the large hall. Mr. Lobley was good enough to have the hall lighted last night, and I made a careful inspection of it, and there is no doubt that the ceiling is not a "thing of beauty or a joy for ever." But I understand that the acoustic properties of the hall are due to that ceiling; that if it had been covered there would have been an echo like that of the room in which we are now meeting. Therefore perhaps he was right in sacrificing æsthetic views for a more utilitarian purpose. Passing to the free library, I was delighted to find a cellar put to such an excellent purpose as a boy's reading room. It was the only cool room I was in yesterday. There was not the slightest smell of closeness in the room, which is well lighted and ventilated, and I congratulate the boys of Hanley upon having such a delightful place where they can go to in their hours of leisure. I have no doubt that Mr. Lobley advised you thoroughly well when he advocated the high-pressure alternating-current system of electricity, under the circumstances of the works being so far from Hanley, and, as I see from the map, it being a straggling place. Otherwise I am not much in favour of the high-pressure alternating system. There is a considerable amount of loss, and I should like Mr. Lobley to say what he finds the loss to be in sending the current to the transformers, and how much is lost in the transforming operations. In these works he has concentrated the power to some extent. He tells us that he has these compound condensing engines of 200 and 100 H.P., and in addition these large Ferranti alternators. Where you have electricity works, there is a varying load which gradually increases up to a certain point, and then rapidly descends. To my mind it would have been better to have split up the power to smaller units, and had the Willans and Robinson or some similar class of engine; but no doubt Mr. Lobley has good reasons for acting as he has done. There is one thing which is very interesting, the plan for lighting the incandescent lamps. Mr. Lobley, with his usual modesty, has not drawn attention to this. But I was struck with the simplicity and ease with which the incandescent lamps could be lighted directly the arc lamps were switched on. It is a most ingenious arrangement, and I commend it to my brother officials. I notice that the mains and cables are being laid by the British Insulated Company of Prescot. They have a very high insulation indeed, and

the way in which the cables are being laid struck me with admiration. I congratulate Mr. Lobley upon having a meeting in Hanley. He has, I understand, served Hanley for 25 years, and it gave me and my brother officials great satisfaction to know that Mr. Lobley's staff have presented him with a testimonial of their regard, which he most richly deserves.

Mr. E. G. Mawbey said: I have very great pleasure in seconding this vote of thanks. I think we all agree that we shall go back to our homes very much better informed than we came, if we are to judge from this paper and the opportunities which are to be offered to us to-day of inspecting works. We shall also all agree that it is another proof of the great advantage to the ratepayers of entrusting to their borough engineer—when they have the advantage of so able a borough engineer as Mr. Lobley—such important works, because the engineer on the spot has a great deal at stake, especially if he is likely to remain as Mr. Lobley has done. He must go heart and soul into the work, and cannot afford to make mistakes. There is very little said about the sewage, in which I am much interested, as we have so difficult an undertaking at Leicester. I gather from Mr. Lobley's remarks this morning that it is very heavy land. If it is heavy land, with only nineteen acres available, it is not sufficient in area for irrigation or intermittent filtration, and Hanley will have to look to chemical treatment and artificial filtration for dealing with the sewage. With 200,000 people at Leicester, and clay land, we require 1400 acres to clarify the sewage, but we have succeeded in doing so, and are sending out a satisfactory effluent. With regard to the assembly room at the Town Hall, I think you are to be congratulated upon having obtained so large a room for so small a cost, and having succeeded with the acoustic properties. The Mayor knows how much that means to public speakers. With regard to the electric lighting, I do not know that I quite agree with Mr. Boulnois. All I can say is, we have got the same system at Leicester. The works were carried out by Mr. Colson, the gas engineer, who is also the electrical engineer. He advised the Corporation to put down the electric works at the gas-works, because they would have the advantage of delivering coal by canal, of being outside the town, and of concentrating the departments together. I can say that Leicester has not regretted adopting this system. No doubt there is a loss in transforming; but turning to another part of the paper, Mr. Lobley very modestly says,

"regarding the financial aspect of this undertaking, the ratepayers have every reason to be satisfied with the prospects." I think they ought to be eminently satisfied at the success already achieved. When you see an undertaking that within twelve months has to double its load, and loans, and can supply current and make a profit on it at 5*d.* and 3*d.* per unit, I think it speaks volumes for the success of the undertaking. It is, of course, a very fortunate thing that you had a borough engineer who could rise to such an undertaking, and remain among you to direct it so that there are such splendid prospects of ultimate success.

Mr. Boulnois: Speaking of public street lighting, Mr. Lobley says the contract includes provision for 30 arc lamps of 1200 candle-power each, of 400 watts. Is that correct?

Mr. Lobley: There were thirty of these lamps in the first contract and thirty in the second.

Mr. S. S. Platt said: I should like to add my meed of praise of Mr. Lobley for the admirable paper he has prepared. Perhaps it is not generally known that I was a pupil of the previous Borough Engineer of Hanley, prior to Mr. Lobley's appointment, and consequently I know something of the work which has been done here. There is one question I should like to ask Mr. Lobley—whether the differential rate for electricity supplied to churches and other places of worship has been taken advantage of. To me it seems a new idea to make a differential rate in the case of churches and chapels, but it appears to be the right thing to do, because it is utilising the electric energy on the day when the shops and places of business are closed, and there is less demand on the electrical plant. I can corroborate Mr. Lobley's remarks as to the improvement which has been effected on the Stoke road. I knew the road before anything was done, and I think it one of the greatest improvements which have been effected in the borough. I commend it to the younger Members of the Association, not to be afraid of advising a similar improvement in their own districts, where it can be seen to be an advantage. Mr. Lobley has mentioned the difficulty of rearrranging the wards of the borough. In my own borough of Rochdale, twenty-five years ago we had a similar rearrangement of the wards, and the same plan was followed of giving each representative a share of the centre of the town and of the suburbs.

Mr. J. Lobley, in replying to the vote of thanks and discussion on the paper, said: I thank you very much for the vote of

thanks, and I will not detain the meeting with any very lengthy remarks. With regard to the loss on the high-pressure system, I think the electrical engineers, who are both present, will corroborate me in putting the loss at 5 ampères at 2000 volts as the amount of loss. That is to say, that is the registered amount of current which goes out of the station, and includes any lamps that may be lighted during the day, and the whole of the transformer losses. We have a considerable number of transformer stations. Our first compulsory area was 35 acres, and we now cover 400 acres. I am inclined to object to the word loss. It is true that it is a loss electrically, in the same way that you cannot get the full duty out of coal. We do our best to get the duty out of the coal with improved engines and boilers, and we do our best to get it in the distribution of electricity. At the same time what do the low-pressure stations do? The great advantage is that they can use accumulators. They can shut down at eleven o'clock at night, and work from the accumulators until sunset the next evening. That is a great advantage, but they have to pay for it. For each kilowatt they put into secondary batteries they get a much reduced amount out. I should not like to value the magnetising current at the same price as we sell it at; that would be hardly fair. If you turned out finished doors and reckoned them at the finished price, you would hardly value the shavings and the sawdust at the same price per cube foot. As regards the sizes of engines and dynamos, the tendency is growing to put down large units of plant. We do not want small units with the alternating system, except in the daytime and for our light loads in the summer. We hope to have a sufficient load for our smallest engine of 100 horse-power, but for other work we shall not find our 300-kilowatt alternator too large. The Willans and Robinson engines suit the conditions for a low-pressure station, but they were not known when these works were started, as applicable to a high-pressure system. We have one church lighted up entirely by electricity. The installation has been put in this year. There is no doubt it is an advantage to us to get customers on Sunday evenings. We have a good deal of spare plant, and we are compelled by the Board of Trade requirements to keep the engines going. As regards the additional land, it will not be a sewage farm in the ordinary sense, but filtration areas. With the filter beds we have in use we find the land very heavy; in fact we have the greatest difficulty to persuade the water to go through it. I thought of burning it and mixing it with sand,

so as to make it more permeable. Unfortunately we are hemmed in by other towns. If we must have a large area of land we should have to pump the sewage a considerable height and take it a long distance. We hope that chemical precipitation and treatment with filtration will improve to such an extent that we can put the effluent into the river without polluting it.

The Members then inspected the various departments of the Municipal Buildings, including the spacious Victoria Hall. Here the Members were entertained to light refreshments by the Mayor and Aldermen Shirley and Ridgway. A hearty vote of thanks was accorded to these gentlemen for their kindness. Alderman Ridgway, in acknowledgment, remarked that as chairman of the Works Committee he had worked with Mr. Lobley for twenty-five years without a single cross word.

The Members then visited the Free Library, the Museum, the High Grade School, the Park, Electric Light Works and Sewage Precipitation Works.

Here Mr. J. Lobley said: I wish to remind the Members that when we were at King's Norton about six weeks ago we had the opportunity of seeing the system in working order. Mr. Godfrey has established this system there and it is working very well, but it is only dealing with 50,000 gallons a day, whereas we have nearly 3,000,000 gallons a day to treat. At that time the Town Council had not thought of putting this plant down, and what you have seen to-day has all been done since the King's Heath meeting; but I am sorry we could not complete the arrangements, though Mr. Hope and Mr. Quick, the Sewage Works Manager, have worked very hard to do so.

Mr. A. P. Hope, M.P.S., F.C.S., said: We very much regret that we cannot show you the process to-day in full working order. The plant, as you see, is erected, and it was really one pipe that stopped us this morning. I can, however, tell you about the chemistry connected with the Bacillite process. The idea is this—we treat the sewage with lime and protochloride of iron. This protochloride of iron is made from a bye-product in one of the iron trades, consequently it is very cheap; and mixed with lime, I know of no precipitant that is better. After the sewage is precipitated with this lime and protochloride of iron we pass it through batteries. If there is any excess of lime, producing alkalinity, you

can neutralise your free lime with carbonic acid gas, which is made from the coke fuel used in the boiler. If the sewage is very weak, you can precipitate with lime alone. You know that an alkaline effluent is condemned immediately. The carbonic acid gas is dragged into the effluent in the batteries with an induced current of carbolic and cresylic steam, generated by distillation and introduced at the bottom of chambers through which the effluent has to pass. This treatment with the germicidal steam is the main feature of the process, as it destroys all putrefactive germ life in the effluent. It is then passed through a Howitson or any rapid mechanical filter—one that can be cleansed regularly every twenty-four hours. These filters pass about 16,000 gallons per square yard. The result is a clear, bright and perfectly innocuous effluent, which can be submitted at any time to any test, and it will be found no putrefaction can be produced; and you may be quite safe that you will not be condemned by any authorities. Of course it is possible to further reduce the albuminoid ammonia by passing over oxidising beds at a further cost of 12*s.* per million gallons, but it is not necessary.

ANNUAL MEETING AT BRIGHTON.

June 25, 26 and 27, 1896.

THE PRESIDENT'S ADDRESS.

By FRANCIS J. C. MAY, M. Inst. C.E.

I APPRECIATE most fully the great honour you have conferred upon me by unanimously electing me as your President for the ensuing year. I therefore feel it my duty to take the earliest opportunity of expressing my most heartfelt thanks to you, as I now do, for this honour, the highest it is in the power of the Association to confer upon one of its Members. In accepting the office, I recognise the important fact that the honour carried with it a great amount of work and responsibility. It will ever be my earnest endeavour to emulate the good example of that long list of illustrious men who have in past years filled the office so worthily, by promoting the interests of the Association to the utmost of my ability; and I know I may rely upon the cordial assistance of all the Past Presidents, the Council, and the Members generally, to enable me to make the ensuing year one of pleasure and profit to all, individually as well as collectively. This knowledge enables me to accept the office without that feeling of fear and trepidation which would otherwise prevail within me.

In selecting the matter for this address, I find it somewhat difficult to follow the usual practice, by which the President for the year has generally described the works of the town which he represents, inasmuch as a largely attended District Meeting was held in this town last year, and a full account of all the works executed, in progress and in course of preparation were fully described in detail by myself and my colleagues, and our papers have appeared in the last volume of our 'Proceedings' recently

issued. I shall therefore only refer to them incidentally *en passant*, as, although they are progressing as rapidly as the exigencies of each case will permit, with one exception (the destructor) they are not yet completed. If, a year or two hence, when they are finished, the Members of the Association deem them of sufficient interest to lead to the arrangement of another District Meeting to inspect them, I shall then be pleased to furnish them with all further particulars.

My remarks, therefore, will be confined more particularly to the objects of the Association, the professional duties and responsibilities imposed upon the Members generally, and other kindred matter which it is well for us to review and consider occasionally, or which it may be well to bring under the notice of the public from time to time, so that the relation of the municipal engineer to the community he serves, through its elected representatives, may be better understood and appreciated. On this point I wish to state distinctly that, although my experience, like that of most of my professional brethren, has been of a most varied character, the Corporation of Brighton is one of those authorities which set a good example to others in the relationship between it and its officers. So long as an official shows that devotion to, and diligent discharge of, his duties which the Corporation has a right to expect, that official will be a happy man, and the most cordial relations will exist between him and the Corporation, and he may depend upon receiving that kind consideration and sympathy which he also has a right to expect from them.

I think that, as Members of the Association, we have every reason to congratulate ourselves upon the position our Association has now attained. Marshalled into existence, as it was, in the year 1873, under the careful guidance of its Founder and First President, Mr. Lewis Angell, with a total number of only 164 Members at the end of the year, it has steadily increased in numbers so that, as you have already learnt from the Annual Report of the Council, we now have a roll of more than 700 Members.

During the past three years 200 new Members have been added to our list, a fact which alone, I think, fully justifies my decision to dilate on the objects of the Association and the advantages of membership.

Our Members now are scattered over the whole of the United Kingdom, our Colonies, Canada, Australia, India, and even China

and Japan. There are still many gentlemen eligible for membership who are outside the pale, and I trust that during the ensuing year we shall all join in making the advantanges of the Association more widely known, so that at the next annual meeting a further great increase of numbers may be recorded.

As one of the oldest Members of the Association, having joined it in the second year of its existence, I am able to appreciate the advantages of membership most thoroughly, and to commend them to my younger brethren with every confidence.

The great advantages I personally gained during my younger days, when, as is known to my older confrères, I never lost any opportunity of attending the District Meetings, wherever they might be held, regardless of distance, inconvenience or expense, induce me to advise my younger brethren to avail themselves of every like chance of inspecting the work of other engineers which the Association offers. This is one of the best means I know of becoming acquainted with the rapid progress that is continually being made in engineering and sanitary science.

The chief objects of the Association are threefold.

1. To encourage such intercourse among its Members as shall afford opportunities for an interchange of the experience and practice which prevails within the department of a municipal and county engineer or surveyor.

2. To promote the advancement of engineering and sanitary science as applied to municipal work, and a continuous progress in the knowledge of all the duties imposed upon the engineer or surveyor by the Public Health, Local Government and other kindred Acts of Parliament, passed from session to session.

3. To further by all legitimate means the professional interests and status of engineers and surveyors engaged under municipal and other local governing bodies.

This is the first occasion on which these objects have been publicly announced in the country south of the metropolis. Our friends who are with us to-day as visitors will therefore observe that when we meet on such occasions as the present, it is not as Members of a mutual admiration society, nor are we altogether on pleasure bent, although we do endeavour to get as much pleasure as we can from the renewal of old friendships during these visits, but that we come to work, to criticise and to learn.

Both scientific and practical knowledge up to date are required of the engineer and surveyor of the present day, and our confrères

have always generously supported the efforts of the Council to provide this at the District Meetings, by writing and reading papers upon the leading subjects of our practice, which may be of local or general interest (often at great inconvenience and labour to themselves, owing to the heavy demand usually made upon the time of public officials), and by affording facilities for the inspection of the various works in their respective localities. The public discussion and criticism of these papers, and the friendly interchange of opinions thereon between the Members during the visit, is one of the best means of education one can devise, and the Authorities whom we serve respectively, and through them the public generally, reap the benefit of the knowledge gained by these means. I hope that all the papers which have been so kindly prepared for reading at this meeting, will be so fully discussed that we shall all feel we have spent the time profitably, and that even the oldest Member may have learnt something; for it may truly be said that an engineer's education ends only with his life. The progress of civilisation is very rapid, and is shown by the great number of Acts of Parliament which are passed every session, throwing additional duties and powers on local authorities. Engineering, too, in all its varied branches, makes such rapid strides and plays such an important part in that progress, that unless an engineer takes the pains to keep pace with the advance he soon becomes a fossil. That which is new to-day will be old-fashioned and obsolete a year or two hence. We have only to look into some of the early volumes of our valuable 'Proceedings,' to prove the truth of this remark. How improved or changed are many of the various matters, ideas or opinions therein expressed, compared with those of the present day! How can we, then, keep ourselves better acquainted with the progress made in the different subjects within our own particular sphere, than by attending such meetings as are arranged for us under the auspices of this Association, whereby we are enabled to visit in turn all the great centres of work throughout the United Kingdom, and even on the Continent? How can we better qualify ourselves for the duties of our individual appointments, and render ourselves more useful to the community we serve, than by storing up and taking home the lessons we learn by hearing these papers and discussions, and by seeing the great works that are being carried out in the wide world beyond our own little local orbit; so that when called upon to advise, or to design some local improvement or advancement, we are able to

give our Corporation or Council the benefit of the latest experience in any particular line. In this way we assist in the advancement of engineering and sanitary science, and promote progress in the knowledge of all the other duties relating to the office of a municipal or county engineer or surveyor. The success of the individual, however, must depend largely upon his own earnest thought, and hard, unseen and unknown study. The advantages offered by this Association do not supersede, but are auxiliary only, to such private or individual efforts.

I think that one grand work promoted by this Association, of which the value cannot be over-rated, is the advantage afforded to our pupils of joining as students or graduates, after having passed the examinations so wisely instituted by the Association a few years ago. Engineering, as a science, has numerous branches. We recognise the Institution of Civil Engineers as one which embraces all sections of the profession, but our Association represents the branch of municipal engineering and sanitary science only, and its members are therefore peculiarly well qualified to teach, to examine and to certify as to the qualifications of those students whose aim is to occupy official positions under local authorities. The municipal engineer's office is undoubtedly the best school in which such aspirants to official life can be trained; and the gentlemen appointed by the Council to act as examiners are especially well qualified to judge and to certify as to the soundness of the training of a pupil, and his fitness for the duties of a municipal engineer.

The certificates issued by our Association to qualified students ought to be most eagerly sought after, and highly prized by all candidates for office. I am also of opinion that local authorities would do well, before appointing young engineers to office, to require them to produce the certificate of the Association, in addition to other testimonials, as corroborative evidence of the correctness of such testimonials as to their proficiency and general fitness for the duties and responsibilities of office.

That the status of the municipal engineer has improved since the establishment of our Association there can be no doubt, and I regard this system of voluntary examination as one means among others by which it will be still further improved in the future. Amongst other matters I should like to see some arrangement made, whereby, when appointed to office, the salary of the engineer should be settled on a sliding scale, advancing gradually to a fixed limit. Also a further arrangement by which superannuation may

be secured to those who, having borne the heat and burden of the day in an honourable manner, may retire at a suitable age or when incapacitated by ill health, and spend the evening of life in serenity. I am confident that it would tend much to the interest of the community, if an officer can feel that it is unnecessary for him to be always seeking a higher and a higher appointment, in order to secure that ease and comfort in the declining years of life which every good man desires, has a right to strive after and to obtain. This may be accomplished in our own particular sphere just as easily as it is in many other departments of official life, without unduly interfering with freedom of action by the local authorities on the one hand or by the officer on the other.

It has been suggested by some Members that the position of an engineer would be improved if he were protected by the Local Government Board and had a right of appeal thereto, as have some other public officials, but I do not hold that opinion. I think that if the difference between a local authority and its officer be so great as to necessitate an appeal to the Local Government Board or any other tribunal, it would be better that the officer should retire, even if the tribunal were to favour his views more than those of the authority. No work can be successfully carried out when there is not absolute confidence between the authority and its officer. This leads me to observe that in addition to the qualifications I have already named as being required of a municipal engineer, viz. scientific and practical knowledge, there must also be a large amount of common sense and tact. The want of these latter qualities will often render nugatory the best effects of the former qualifications, and I recommend our younger brethren, students and graduates to well consider this fact. It has been said that man's chief study should be man. I commend this idea also to my younger friends, strive to know thyself—but don't stop there—try to know also those whom you serve, or with whom you may have to work, or over whom you may be placed, in whatever capacity they may be; then, discreetly controlling your own words or actions, and as discreetly leaning towards the peculiarities of others, you may prevent a deal of unnecessary friction, which is so irritating, and promote that degree of harmony and friendship which conduces to mutual forbearance and respect of each other's feelings, and lays the foundation of an increasing and mutual confidence. It is quite as essential to be clever in engineering men as in engineering matter. I speak strongly on this subject, having learnt the lesson

from my own experience. I frankly admit that often on calmly investigating the cause of my troubles and disappointments, especially in my younger days, I have come to a conclusion that they often arose from some little indiscretion on my part, leading to an absence of a due regard for the opinions of others. As a rule we tone down considerably as years roll on, and become less impulsive and dogmatic, and it is well it should be so. If these remarks should lead any of our younger brethren to avoid errors into which I may have fallen in this respect, and their disagreeable consequences, and so help to promote in them a happier and easier life, my purpose in making these remarks will have been well served.

That the duties of the engineer or surveyor to a local authority are in most cases heavy and multifarious to an exceptional degree, may be readily recognised by even the most uninitiated, by a review of some of the subjects upon which we are called to advise our authorities, and afterwards to receive and carry out their instructions. That they are extremely varied in character, and therefore require a wide field of education and knowledge, is equally obvious. That they are ever increasing in number or degree is also quite clear, when we think of the number of new or amending Acts of Parliament, casting additional duties and responsibilities upon local authorities, which are passed every session; of which it may truly be said that most of them throw, directly or indirectly, some additional duty upon the surveyor to the authority. I find upon reference that no less than thirty-five such Acts have been passed during the last seven years.

The wave of centralisation which ruled us so long has turned, and the spirit of the present age is decentralisation. The principle has made considerable progress during recent years, but I expect your experience has been of much the same character as mine, and so you will agree with me that a good many local improvements are often unnecessarily delayed, crippled or stopped altogether by too much grandmotherly interference by the Local Government Board officials, so that further progress in this respect is urgently needed. The change, however, has already produced among all classes a greater interest in the management of local affairs, a higher tone in regard to the value of human health and life, and an honest desire to promote the general well-being of the community. Improved sanitation is now still further demanded. Improved dwellings for the working classes is one of the leading requirements of the age, including the better housing of the nomadic class in

municipal common lodging houses; the preservation of existing open spaces or the acquisition of new ones, and fitting them for health-giving or recreative purposes; the establishment of technical schools, free libraries and reading rooms; the provision of greater supervision of places of business where many persons are occupied daily, to secure better sanitation and ready means of escape in case of panic or fire; these and many other subjects that might be mentioned, have within recent years added much to the labours and responsibilities of a municipal engineer. It may, therefore, be easily understood that such a man, to be efficient, must be a man of cosmopolitan knowledge and ideas. It is because this is so that an Association such as ours becomes so important and valuable. I shall do all I can during my year of office to render it more valuable still, making it and its objects as widely known as possible.

Before passing on to speak of local matters, perhaps a short comparison of the "past" and "present" of municipal life will not be considered out of place.

We are all aware that Municipal Government has existed in England from early times—the oldest Municipal Charters date from the year 1132, and were granted by Henry I. There was always a Mayor, and of course a Town Clerk, but I have been unable to discover any trace of a Borough Surveyor till modern times, and the Borough Engineer is of still more recent date. The principle of local self-government, or decentralisation, was very dear to our early forefathers in the towns, who resented strongly the interference of outsiders, even from the adjoining country; for I have read in the history of town life in the fifteenth century, that the chief magistrate set over the inhabitants must be one of their fellow-citizens, "not a far dweller," unless in time of special need, such as war, and then only "by pleasure of the community."

The dignity of the office of Mayor was as great, and the honour as highly prized then as at the present time; and in those early days the duties of the Mayor were certainly quite as onerous as those of the present time, for on the day that each new Mayor entered on his office, he received from his predecessor the common chest, the town treasure, and the standard measures, and was required forthwith to send out his Councillors to the house of every shopkeeper, baker, brewer, or innkeeper, that they might carry all bushels, gallons, quarts, yards or weights back to the Mayor's house to be compared with the standard models and duly sealed.

Those who aspired to and attained the dignity of Councillor found too, in those days, as at the present, that the office was no sinecure, but made heavy demands upon their time, their talents and their pockets.

From this statement of the Mayor's duties in olden times it is evident there was neither a Borough Treasurer nor an Inspector of Weights and Measures. There was, however, a Town Clerk, and as at the present time, he was always expected to be a man of learning, but I believe it is at Nottingham that we have the first evidence of a Town Clerk, from 1534 to 1545, who knew enough of the classics to quote a line of Virgil and a line of Horace; but in 1587 they possessed a Town Clerk who, in addition to the erudition of his predecessor, was also learned in Greek. In reading the history of 'Town Life in the Fifteenth Century,' we find many of the same social questions troubling the Town Council then as now, and the duties devolving upon them of the same character. In many towns, education, both technical and otherwise, was governed entirely by the Town Council, as at Nottingham and Bristol, among others.

It is therefore evident that in municipal work and life, as in other things, there is nothing new under the sun. Men and manners only change, matter always remains pretty much the same, but is dealt with in a more or less modernised way according to the progress of science, and the prevailing requirements and notions of the times. During the present century science and learning have made more rapid strides than in any previous period. In municipal work and life they have had the effect of giving birth to the office of Borough Surveyor, Medical Officer of Health and Sanitary Inspector. The office of Surveyor of Highways was established by an Act passed during the reign of Queen Mary, 1553 to 1558; but the office of Borough Surveyor and its additional duties was made to apply generally for the first time by the Towns Improvement Act, 1847, although Brighton in 1825 (see Sec. 21, 6 Geo. IV., cap. 179) and some other towns had instituted such an office by a private Act. The offices of the Medical Officer of Health and Sanitary Inspector by the Public Health Act of 1875. It is the Towns Improvement Act, and the various Public Health Acts that have followed since 1847, that have given so great an impetus to engineering and sanitary science. It is during the last fifty years, during the operation of these Acts, that all the great improvements have been carried out, such as improved roads and pavements, water

supply, subsoil drainage and great sewerage schemes, whereby the death rate has been so considerably diminished. These Acts have made local authorities almost wholly responsible for the health, education and comfort of the people living within their respective areas, and these responsibilities are increasing every year. We, as municipal engineers, are required by our respective authorities to be prepared to advise and to carry out, under their direction, those great works and innumerable duties within our department for which they are responsible. How great, therefore, is the necessity for making ourselves thoroughly competent in every detail of our work, and fully acquainted with all the latest improvements in engineering science and practice. Our duties and responsibilities are ever increasing, and let us hope that as our efforts to render ourselves efficient and useful to the community we serve become better known to them and the local authorities, they will be better understood and appreciated, and that our services then will be remunerated in due proportion to their real value, as I am sorry to say is not often the case now. This Association affords us every opportunity, and it should be recognised and assisted by all local authorities on account of the good work it has done and is still doing.

I think one way in which the usefulness of the Association may be further promoted, is to make local authorities better acquainted with its principles, and so induce them to take an interest in it, and to encourage their officers to do likewise, by readily granting them the time to attend the several meetings, and by paying their travelling expenses. I think, too, that, if possible, our rules should be altered so as to admit to all our meetings the Mayor and the Chairman of the Works, Sanitary or and other Committee affiliated with the work of the engineer's or surveyor's department, from every town or rural district council represented by a Member, should he or they desire to attend any of them.

I know from past experience, that chairmen are often most anxious to become well acquainted with the details of the work governed by their respective committees. I believe many would avail themselves most readily of the right to accompany the engineer or surveyor to our meetings, and join in the discussions if invited to do so. This would induce a friendly feeling towards the Association, and in my opinion be a mutual advantage, as in the discussion we should also hear opinions given from another standpoint than our own, or, in other words, the other side of the question.

It should be constantly borne in mind that by giving municipal officers every facility for attending the meetings of the Association, so that they can examine and discuss the various methods which other bodies have adopted for dealing with questions that are common to all communities, the various authorities are contributing in perhaps the greatest degree to the commonweal of the whole country, and are most truly fulfilling the duties which their position involves. And considering the fact that the Members voluntarily attend these meetings at considerable inconvenience and expense individually, but with great profit to the public generally, the authorities whose districts are visited should offer every encouragement and hospitality in their power to lighten that which to many is a heavy tax upon a small income.

The hearty reception which has invariably been accorded to us in those towns we have already visited (many more than twice or thrice), is a proof that when the Association and its objects become known, the respect and support of the governing bodies is most cheerfully given to it. Let us therefore do all we can to extend that kindly feeling, not from personal motives, but because it will enable the authorities and their officials to work together more harmoniously and effectually for the commonweal.

I will now pass on and briefly allude to some of the public works carried out within the borough by the Corporation of Brighton, which will prove that in the past, as at the present, they have been and are very energetic in the pursuit of their duties, to ensure the prosperity of the town, the welfare of its inhabitants and the comfort and pleasure of its visitors.

You will have opportunities of inspecting all these works during your visit.

Since the passing of the Towns Improvement Act in 1847, they have secured two private Improvement Acts giving them additional powers for the better government of the town to meet special local requirememts. More than 70 miles of roads and sewers have been constructed, 10,000 houses have been built, adding considerable mileage of house drains, which it is impossible to estimate correctly. Of these, 40 miles of roads and sewers and 4000 houses have been added during the last twenty years.

During the years 1894–5 a new main valley sewer with storm water overflow chambers, and outfalls into the sea at the Albion and Norfolk Groynes, were constructed at a cost of 33,000*l.*

The Madeira Road or undercliff drive, with its Shelter Hall and

Colonnade, finished in 1890, cost 15,000*l.* and a further improvement and extension of the road and Colonnade is now in course of progress at an estimated cost of 20,000*l.*

The Corporation Electric Light Station was built, and the undertaking started in 1891 at a cost of 21,000*l.*, and further extensions are now being constructed at an estimated cost for buildings, machinery and mains, of 12,400*l.* The whole of the front, nearly three miles in length, and the principal streets are lighted by arc lamps, and the side streets by incandescent lamps. This undertaking is one of the most successful and flourishing in the country, under the guidance of Mr. Arthur Wright, the Engineer and Manager.

Sea-defence works, such as walls and groynes, have been constructed at a cost of about 220,000*l.*, by which upwards of 21 acres of land have been reclaimed from the sea and added to the foreshore, so that it has been possible to widen the King's Road three times, to its present noble proportions.

The cost of these widenings and improvements has been about 84,000*l.*

The Waterworks were acquired from a private company at a cost of 352,000*l.*, and additions to the works have since been made which have raised the capital account to nearly 540,000*l.* A most abundant supply of water, drawn from deep wells in the chalk, is provided, and is of an exceptionally pure and excellent character. This department is most ably managed by Mr. James Johnston, the Engineer.

Public parks and open spaces to the extent of 200 acres have been acquired, principally through the generosity of local-spirited men; and about 31,000*l.* has been spent by the Corporation in fencing and laying them out, &c. &c.

The Royal Palace, known as "The Pavilion" has been purchased and restored at a total cost of about 82,000*l.*, as a pleasure resort and place for public or private entertainments.

The Sanatorium, or hospital for infectious diseases, was built at a cost of 10,000*l.* out of current rates, but it is shortly to be rebuilt at an estimated cost of 27,000*l.*, provided by a loan recently sanctioned by the Local Government Board, after much correspondence and trouble, due to their usual grandmotherly interference already referred to.

A Municipal Technical School is in course of construction, at an estimated cost of 22,500*l.*

The Town Hall is to be enlarged and remodelled at an estimated cost of 30,000*l.*

Slipper baths have been constructed in four separate establishments in different parts of the town.

A new swimming bath was opened last year.

The Public Abattoir was opened in June 1894, and the Refuse Destructor, built by Messrs. Manlove, Alliott & Co., and fitted with Messrs. Boulnois & Brodie's Patent Charging Apparatus, was fired for the first time in May of this year.

We are extremely fortunate in the matter of sewage disposal. The whole of the sewage of Brighton and Hove is collected in an intercepting sewer which runs right along the front, and for a distance of seven miles beyond the eastern boundary of the borough to Portobello, where it is discharged into the sea as the tide serves. At Roedean, about one mile from the eastern boundary, a ventilating furnace was built to draw the gases from the intercepting sewer. This has been most succesful in accomplishing its effectual ventilation, and in preventing the gases from rising to the higher levels of the main draining area.

You will readily understand that the sanitation of this important "health resort" and "pleasure town," is of primary importance. In the entire absence of manufactories and the ordinary industries of commercial towns, our prosperity and even our very existence depend upon its popularity. The Health Department, under the direction of Dr. Newsholme and his large staff of sanitary inspectors, is very ably managed. All the best sanitary measures and arrangements are adopted and strictly enforced.

The detail drawings relating to the several works mentioned are exhibited in the adjacent rooms, and will, I think, enable you to understand them easily.

I will not therefore take up your time now by a fuller description of these various undertakings and works of the Corporation, as they were very fully described in the papers included in the last volume of our 'Proceedings,' as I have already told you. We shall visit, or pass by, most of the works and places named, and I will then give any further information respecting them which any Member may desire.

In proceeding to close this address, I would like to remark that in the past it has unfortunately been too much the practice for the Association to depend upon the senior Members to furnish papers for discussion. We therefore do not get that variety of subject

matter which might be obtained if the number of writers were increased. I am sure the surveyors of some of the smaller towns or even country districts, must have much experience which, inasmuch as it differs from that gained in larger towns or districts, would be found both interesting and instructive to us all; therefore I take this, my last opportunity, to emphasise again the value of this Association, and to urge the younger or new Members especially, to strive to extend its usefulness by preparing papers to be read at the meetings; by bringing into the fold those gentlemen who, though eligible, have not yet joined our community; and by bringing the existence of the Association and its advantages to the knowledge of their individual local authorities, so as, if possible, to gain their hearty sympathy and cheerful co-operation.

The local authorities are the elected representatives of the people, and are entrusted with their confidence to advance by all means the welfare of the community. All our labours as municipal engineers and surveyors tend to promote, either immediately or eventually, the public advantage and the public benefit. It is by the free and friendly interchange of ideas among the Members of the Association, and by the strengthening of the already strong bond of sympathy between the local authorities and this Association, that this common beneficial result can best be effected and advanced. I believe we have a great future before us, a future of which we can form no idea by comparison either with the present or the past. There is no finality in our work. Fifty years ago we were not, but we are now a powerful body, and a recognised influence in the municipal life of the nation. We are what we are simply and solely through our own exertions—a position of which no one can be more proud than I am myself—and what we may be rests not only with the generations who will succeed us, but in a very great degree with the generation of engineers and surveyors which is now so full of life and activity. Our exertions, and those of our predecessors, have only been called forth by the constantly advancing demands of civilisation, and our successors must, as we have to the best of our abilities tried to do, keep well abreast of the times, even if not a little before them.

"Onward, ever onward," must always be our cry, and as long as we have this in our ears, and friendship, unity and concord in our hearts, our words and actions regulated by that absolute truth in all our bearings, without which we know as engineers that no machinery can work efficiently, so long shall we go on increasing

and enlarging our sphere of knowledge and usefulness to ourselves and to our fellow men, a sphere to which I can see no limit, and a sphere to which I believe there is no limit.

In conclusion, I have only to endorse the welcome which the Mayor and Corporation have accorded to you—to thank those gentlemen who have so kindly prepared papers for our consideration and discussion—to ask you as the greatest compliment you can pay to the Authors of those papers, to discuss them as fully as they will admit—and to express my earnest wish that both from the subject matter of the papers and from the inspection of our works, much profit and pleasure will be derived, so that you may return to your respective scenes of work, feeling that your visit to the Queen of Watering Places and Empress of Health Resorts has been a profitable expenditure of both time and money.

RIVER POLLUTION.

By PROFESSOR HENRY ROBINSON, M. Inst. C.E.

The subject of "River Pollution" is now entering upon a new phase, and the Members of this Association know that in the immediate future, remedies will be enforced to prevent the continuance of the pollution of rivers.

The Author intends to confine this paper within very brief limits, and to refer only to the main points which now deserve attention.

From 1876 (when the first Rivers Pollution Prevention Act was passed) until the last few years, the powers that had been conferred by Parliament to prevent river pollution were not only of too permissive a character, but as a matter of fact those who had to enforce them were generally the very offenders themselves.

The Local Government Act of 1888, however, gave County Councils power to enforce the Rivers Pollution Prevention Act of 1876, and it enabled the Local Government Board to form joint committees to deal with river pollution. In 1892 the Mersey and Irwell Joint Committee obtained an Act, which was followed in 1894 by the West Riding of Yorkshire Rivers Act. By these Acts a step in the right direction was made.

The Rivers Pollution Prevention Bill now before Parliament indicates a further advance, as the following "Memorandum" attached to the Bill shows:—

"The principal object of this Bill is to improve the law for preventing the pollution of streams by extending to County Councils, Joint Committees and Rivers Boards in England the main provisions of the Mersey and Irwell Act of 1892, and the West Riding of Yorkshire Rivers Act of 1894, &c."

It is well known that rivers are fouled by the discharge into them of polluted water from canals or canalised streams, and this is prohibited by the Bill. Many canals are seriously polluted and constitute a danger to health. Besides the foulness of the water, the mud deposited in their beds is decomposing filth, the outcome of long continued pollution.

Lord Thring has a Bill now in the House of Lords, by which

County Councils can cleanse watercourses and improve the channels of rivers. This indicates an appreciation of what actually exists, inasmuch as many river beds and canal channels are so fouled that artificial cleansing is imperative, as the self-purifying action is arrested owing to the absence of free oxygen, which is so essential to effect this.

Section 3 of the Rivers Pollution Act, 1876, has now been amended in a very important respect by the provision that the passage of sewage matter into a stream through a channel which is vested in a sanitary authority shall be deemed to be knowingly permitted by the authority.

Besides prohibiting the deposition of solid refuse in streams, the Bill now before Parliament prohibits solid refuse, as well as sludge, solid sewage matter or putrid solid matter, being placed in such a position as to be liable to fall, or be carried, into a stream. Those who have had to trace and note the causes of pollution in streams will appreciate the usefulness of this provision, as many serious causes of fouling arise from refuse from works or farmsteads passing direct, or being washed into the stream by heavy rains.

The admission of liquid manufacturing refuse into sewers has often increased the difficulties attending the treatment of sewage at outfalls, and Section 7 of the Act of 1876 (which permits the authority to allow this) has often led to abuse of the sewers. In future, however, it is to be anticipated that these facilities will be very much curtailed, inasmuch as the Local Government Board have on two recent occasions required schemes to be amended in which a large amount of manufacturing refuse was proposed to be admitted to sewerage systems. Section 6 of the Bill of this year prohibits the discharge of polluting liquid from manufactories into streams, unless it can be shown that the best practicable and reasonably reliable means to render harmless the poisonous, noxious, or polluting liquid have been adopted.

There is one definition in Section 29 of the Bill of this year, which appears to the Author to be open to question. It stands thus:—"Solid matter shall not include particles of matter in suspension in water." Section 3 states (as before mentioned) that it shall be deemed an offence to discharge into a stream any sludge or any solid sewage matter or other waste or putrid solid matter. The definition of solid matter given in the Bill would enable foul substances suspended in water which had a sufficient velocity to prevent their deposition, to be discharged into streams.

Flood waters have been relied on frequently to cleanse the beds of rivers which are subject to pollution. As these foul matters are more and more excluded from rivers, the necessity for using flood waters for scouring purposes will disappear, and such waters will then be capable of being stored either for domestic supply or for compensatory purposes. It has hitherto been generally thought that flood waters were not admissible to storage reservoirs that were intended for the supply of water for dietetic purposes. This view, the Author thinks, can no longer be sustained, as the self-purification of stored water is now recognised. The storage of flood water now becomes feasible, and besides largely adding to our available supplies of water for domestic and other purposes, would at the same time mitigate the injury that is now caused by the rapid discharge of flood waters in the lower reaches of rivers after heavy rains.

Those who have now to advise in regard to sewage disposal works should bear in mind that the best practicable and available means of dealing with sewage must not be based upon that which was accepted only a few years ago. In fact, many existing outfall sewage works will have to be rearranged in the light of recent experience, as a higher standard of purity of effluent is now more readily attainable than heretofore.

The further powers now conferred on County Councils, Joint Committees and River Boards will lead to a closer scrutiny of rivers and streams, and to the detection and abatement of pollutions.

The Author has, during this month, had to report on the points of pollution of a stream which may be taken as a type of a vast number of streams in this country, where the pollutions can be clearly traced, and the remedies can be as easily applied.

The Author classified the sources of avoidable pollution broadly under the heads of:—

(*a*) Works or premises from which foul matters can flow or be washed after heavy rains.

(*b*) Farmsteads or dwellings draining into ditches or channels, which ultimately discharge into the stream.

(*c*) Sewage outfalls which discharge polluting effluents, sludge or sewage from works which easily admit of improvement in the light of present knowledge.

The endeavour to utilise for agricultural purposes the manurial ingredients of sewage, too often leads to the practical difficulty of

sanitary requirements being sacrificed to the exigencies of farming operations. The knowledge which is now available in regard to the purifying action of bacteria, indicates that their functions are best exercised by working filtration areas under well-known conditions, which depend on uniformity of treatment and the avoidance of excessive, or variable, volumes. The provision of large areas of land, or of extra tanks, to meet abnormal flows, adds much to the cost of outfall works. The author believes that, after provision has been made for treating on land, or dealing in tanks with the first and foulest discharges from sewers, the large residuum can be deodorised and sterilised without overtaxing the outfall works, so that under no conditions will the streams be made the recipients of polluting matters.

DISCUSSION.

Mr. Clarson, in moving a vote of thanks to Professor Robinson for his paper, said : The question of rivers pollution is one in which I am particularly concerned at the present time. Unfortunately the town and neighbourhood that I represent is situated about twelve miles below the sewage works of Birmingham, and the river Tame into which the effluent is discharged (formerly a clear pellucid stream and full of fish) has been rendered in fifteen years an obnoxious stinking sewer. I think if Professor Robinson had included sewage farms amongst the causes of river pollution, he would have hit the mark better. Birmingham, which poses as the best governed city in the world, is about to take up more land in the endeavour to deal with their sewage more satisfactorily, and they are destroying picturesque rural villages and stinking them out. At Tamworth we have lately spent considerable sums of money in clearing out the filth that has been put into the river by Birmingham. I think this is a very important subject, and should not be lost sight of in the discussion. Some of you may, perhaps, view the matter from different standpoints. Some of you may be in such a fortunate geographical position that the river is your greatest friend ; some of you, as at Brighton, have the sea to depend upon. It is likely I shall be concerned in three actions against Birmingham for the pollution of this river. Not only with regard to the Midlands, but throughout the country, is this a very important subject. The rivers of this country ought to be purified, and, if possible, put into

the state they were years ago. The river Tame is the worst polluted river, at any rate in the Midlands if not in the whole country, and I shall be very glad to take part in any discussion on river pollution and to give any information I can. I hope this is not the only discussion we shall have on the question of rivers pollution.

Mr. Fowler said: The paper read by Professor Robinson is so concise and so *multum in parvo* that there is very little to be said except to echo every word that he has expressed. I consider the powers it is sought to obtain from Parliamant with regard to the Yorkshire and Lancashire rivers, will be a step in the right direction. You must remember that in Yorkshire and Lancashire—you are not, perhaps, all so familiar with them as myself and some other gentlemen here—the rivers are simply like boiling cauldrons. You will see the sulphuretted hydrogen gas formed by the deposits from the manufactories and house drains, bulge up the water in these rivers as if some one had thrown in a large stone; it bubbles up and, as it were, explodes. Where the rivers Mersey and Irwell pass through the neighbourhood there are about a million acres of country studded with manufactories, small and thickly populated towns; in fact they give you the impression of one great town. The river Irwell brings down volumes and volumes of material, not material merely discharged by the sewers, but the ashes and refuse of the manufactories deposited on the banks. The manufacturers do not throw their refuse into the rivers: they put it on the banks during the season of drought, and when the floods come—and you can imagine what the floods are from so large an area, especially when I tell you that in some parts of the district they have a rainfall of something like 47 to 50 inches a year, and sometimes of more than an inch in an hour and a half—the river rises to a great height, sometimes 16 to 20 feet, it brings all this refuse down, and perhaps deposits it in the Manchester Ship Canal; but it is much better now than in the past. I should imagine that the dredging in that canal at the present time must be something enormous, and I should think that the canal, with the expense of dredging and the general working, can hardly pay expenses at the present time. If you go out of the valley of the Irwell you get into the valley of the Aire, and to repeat ancient history, I must tell you that Professor Way, who was one of the gentlemen appointed on the Rivers Pollution Commission of 1865, wrote a memorandum with a portion of the water taken from the

river where it flows past Castleford. It was published in the blue book, and there you have it recorded in 1866, a facsimile of what was written with the waters of the rivers Calder and Aire at their confluence just below Leeds. You can imagine, therefore, the condition the rivers are in at the present time in Lancashire and Yorkshire. If the legislature would only rise to the occasion and put their foot down by compelling municipalities to prevent this deposit in the rivers and this great pollution of towns' refuse, which has been going on for the last thirty years, I think it would be one of the greatest boons it could bestow on this country. We know very well the great distress caused by these foul streams, and we know very well the advantage which would accrue from the great sanitary works which could be accomplished if the rivers were made comparatively pure. With regard to the storage of water, I think the Author of the paper has made a very good point there. You can all of you imagine the advantages that would accrue in the case of the Manchester Ship Canal. If the canal was provided with storage reservoirs in the upper reaches of the River Iwell basin, they would by that means be able to store this great quantity of rainfall, or a great portion of it, and they would then have been able to send down to these manufactories a certain amount of water—which we know they watch so jealously with regard to taking the pure water for water supply—whether pure or polluted does not matter, and distributed it among the manufacturers along the valley, thus supplying the canal at the very time it was needed. I read in the paper the other day, that during the recent drought there was an alarm of scarcity of water in the Ship Canal. If they had had these reservoirs they would to a very large extent have rendered this danger impossible. They could have given the mills a good supply, and have kept up a good stream of water through this now foul and polluted river. In the paper the Author has hit upon two very important points, and I shall have very great pleasure in supporting him on those points. I trust the legislation shadowed forth will be successfully carried through Parliament, and that the local authorities, who are the custodians of the public health, will see that the provisions of an Act of Parliament are carried into force—not a mere ornamental Act like that of 1847, which was nothing more than a dead letter, but one which will strengthen the powers now existing and add the powers now shadowed forth.

Mr. Cox : I think the paper is a model of brevity and terseness,

and I will try to follow Professor Robinson's example. So far as concerns me, the paragraph relating to manufacturers' refuse is the most important. The purification of trade refuse may be a small matter in many towns, but in the town I represent—Bradford—it is becoming a very serious matter indeed. As many of you know, it is the seat of the worsted industry. Large quantities of wool have to be washed, and the amount of grease, sand and greasy matter turned into the sewers of the town is something enormous. It will have a very serious effect on the disposal of the sewage, and we may or we may not be able to take advantage of the provision in Section 7 of the Rivers Pollution Prevention Act of 1876, where it is provided that if the trade refuse is so harmful as to prejudicially affect the sewers or the disposal of the sewage, the authority may have power to prevent the discharge of such refuse into the sewer. That seems to be a very moot point. The discharge of the trade sewage into the public sewers affects us in this way. The grease has the property of holding water, as it were. It causes an emulsion and prevents settlement; in fact it takes very large quantities of chemicals to cause precipitation at all, and when it is settled, instead of the ordinary 90 per cent. of water in the sludge, we have over 98 per cent. Now the serious difference between these two percentages will strike many of you as very remarkable. Ninety per cent. means 9 volumes of water to 1 of solids; 98 per cent. means 49 volumes of water to 1 of solids—5½ times more. The sludge is of so watery a character, it is almost impossible to do anything with it. Even when pressed in sludge presses there is still over 75 per cent. of water left in the sludge, and it is scarcely portable. There may be an escape from this dilemma by treating the wool-washing refuse separately, or by adopting some other method of cleansing the wool. We are now carrying out a large experiment of degreasing the wool by the use of solvents such as bi-sulphide of carbon, so that no soap or anything of that kind will be required in the cleansing process. The chemical could be used over and over again, with the exception, of course, of a small quantity lost in evaporation. There is a possibility that good may come out of evil in the long run, for it may happen that what is now a very great trouble and expense may in the future prove a source of revenue if this experiment proves successful; but unless something can be done in that direction, the outlook seems a very gloomy one indeed. It is very difficult to turn the refuse back

on the manufacturers and compel them to treat it at their own works, for many of them are short of space already. Some manufacturers discharge their refuse into the watercourses, and others into the sewers. The latter look to the Corporation to deal with the question for them. The Rivers Board will look after those who discharge into the rivers. Those who discharge into the rivers ought, in fairness I think, to have the option of diverting the refuse into the sewers of the town, otherwise they will be placed at a disadvantage, although in doing so, I am aware they would be robbing the streams to some extent of water.

Mr. Lemon: Everybody appears to approve of the paper, and as I approve of it myself, I feel some difficulty in criticising it, although we presume that the papers are read for critical purposes. I think there is a gleam of sunshine about it. We have heard from the surveyor of Tamworth that there is going to be an action against Birmingham. I am delighted to hear it. It will certainly be a good field for inquiry for the surveyor of that city when he takes office. I must say that I have not very much sympathy with Tamworth. I saw, when the matter was before the House of Commons, that three landowners appealed against the Corporation of Birmingham obtaining land for the purpose of dealing with their sewage. You will remember the case was very severely criticised by the Press at the time. It was a case in which the Corporation of Birmingham was willing to do the best it could to get rid of its sewage, but was prevented by the landowners from obtaining land for that purpose. I think the question is not so much the dealing with sewage outfalls as of dealing with the pollution of rivers from the causes which have been so ably stated by Mr. Cox. I do not think there is any difficulty in dealing with the sewage of an ordinary town, so as to discharge a pure effluent into the river; but I do know there is immense difficulty in dealing with sewage which has been previously polluted—if I may use the term—by manufacturers' refuse. The resources of the chemist are almost lost. I know chemists, very able men, who have been consulted as regards sewage of this sort, and they have been unable to suggest any method of dealing with it. I think the legislature should give local authorities larger powers to force manufacturers to purify their sewage before it enters the sewer. A manufacturer who has a connection with a sewer and discharges his refuse into it, has a kind of vested interest in it, and there is a very great reluctance on the part of members of a council to take proceedings

against such a manufacturer. I think that manufacturers should be compelled to deal with their sewage before it enters the sewer. They should not be allowed to discharge an effluent unless it is in a reasonable condition—at least as good as an ordinary effluent from a town. They certainly should be prevented from discharging a quantity of polluted matter into a sewer, and then leave it to the local authorities to deal with it, because it is so affected by the mixture of chemicals that it is very hard to treat. I had to deal with a case not long ago in Farnham, Surrey, where 33 per cent. of the sewage was brewery refuse. I advised that the brewery should be compelled to deal with their refuse before it entered the sewer. A long correspondence went on, and litigation was threatened by the local authority, but so far as I know, nothing has come of it. We get at the outfall of the sewage works this large percentage of brewery refuse, which sets up a kind of fermentation, and I do not think there is anything that stinks much worse than brewery refuse. The result is that the difficulty of dealing with the sewage there is much greater than in the case of an ordinary town. I think we should draw the attention of the legislature very strongly to the question of compelling manufacturers to deal with their refuse before it enters the sewer.

Mr. T. de Courcy Meade observed that in dealing with this matter both sides of the question should be carefully looked at. It was easy to make laws, and still more easy to suggest additional restrictions, with a view to the theoretical purification of rivers; but when the practical side of the subject had to be dealt with, it was frequently found that old established manufacturers were so situated that it was almost impossible at a reasonable cost to efficiently deal with the trade refuse before it entered the rivers. The powers at present possessed by the Mersey and Irwell Joint Committee were exceptional, and if enforced to the letter would result in the closing of many works. He did not for a moment wish to argue that it was not a desirable thing to have the rivers as pure as possible, but he would like to mention that statistics of the death rate taken in those portions of a large manufacturing town which immediately adjoined a river, compared very favourably with that of localities situated a little further from the banks, and proved that although the river in question was badly polluted, the death rate in the immediate neighbourhood was lower than that in other parts of the town. He mentioned this merely to show that illness was at times attributed to river pollution which probably arose from other causes.

No doubt the current of air that generally followed the course of the river, helped to neutralise the bad effects which might otherwise accrue to those dwelling in its immediate neighbourhood. Many of the manufacturers within the district under the jurisdiction of the Mersey and Irwell Joint Committee, had constructed works for the purification of their trade refuse, and in some cases they were permitted to pass the effluent (after treatment) into the town sewers. This was desirable where it could be done without causing an undue burden to the rates, or creating difficulties in the subsequent treatment of the sewage.

Mr. McBrair: I feel in listening to the paper, that the manufacturers' side of the question has been overlooked. I do not hold a brief for them, but they are entitled to some consideration, and we must not forget there are two sides to the question. I am acquainted with several works where I cannot see how the manufacturers are to deal with the effluent. There are several works of that kind at Lincoln, and I know distinctly when they send their refuse into the sewer, because it completely blackens my effluent. I am taking samples at the present time to see what can be done. At the same time I am conscious of this difficulty. What are these people to do? They turn many thousands of gallons of refuse into our sewers, but it seems to me that if you proceed too strongly against them it simply means shutting up the works and sending the men adrift. I am sure that on this question there is another side as well as the one we have heard so much of to-day.

Mr. J. S. Pickering: The question of the admission of manufacturers' refuse into the sewers is a very important matter, and I think there should be a day set apart at some of our meetings to discuss it. There was an excellent paper read on the subject some time ago, without a single word of discussion. This paper dealt with the whole matter, but it is impossible in a short discussion to go into the subject fully. There are certainly two sides to the question. It is a very serious matter—for small towns especially—to have to treat the refuse of large manufactories. I can speak somewhat feelingly, because we have this very matter in hand at the present time. We have, I am very pleased to say, been able to persuade the manufacturers, rather through diplomacy than pressure, to move in the matter, and we have fairly satisfactory results. At the same time, I think local authorities should have more power to prohibit these liquids being discharged into the sewers without some treatment. There are factories where it may

be difficult to adopt some particular means of treatment, but I fail to see where there is a factory so placed that it could not adopt any form of treatment whatever. I certainly think that something might be done in this direction. The Author has referred to legislation that is about to be promoted for the prevention of pollution of rivers—legislation that proposes to give further powers to County Councils. This is a step in the right direction, and I think if the County Councils had more power in this matter and the Local Government Board had less, matters would go much more smoothly than at present. The Local Government Board, as most of the Members of the Association are aware, insist on the acquisition of a certain area of land, whatever the condition of the effluent from the works may be. That, in my opinion, is a very great hardship indeed, and particularly in some cases, where it is almost impossible to obtain the land. I know towns that have had to adopt the suggestions of the Local Government Board, and have had to acquire land, knowing at the same time that the system they are adopting would be a complete failure. There is another point I should like to bring before you. I think that before Bills are submitted to Parliament it would be a good idea if this Association could thoroughly discuss them. I consider if this course were adopted there would be fewer blunders put into the Acts. We know that there are lots of matters on which the Public Health Acts fail, because the Bills have not been submitted to some institution that understood the matter. For instance, if this Association had had some voice as to the definition of a drain and a sewer, and as to what was a street and a first floor, the present difficulties as to these matters would not exist.

Mr. Fowler: I may add that the town of Brighouse, in their new scheme for which I am engineer, practically passed a resolution to take all the manufacturers' refuse into the sewer.

The President: I quite agree that our thanks are due to Professor Robinson for his admirable paper on a subject which is of the greatest importance to the country generally. Fortunately for me it is one which at the present time does not concern me personally very much, but I have in my past career been situated as many of you are at the present time, where the question of river pollution and the treatment of manufacturers' refuse was one that gave me considerable trouble. I have been in a similar position to that spoken of just now by Mr. McBrair. I have seen the River Medway turned into a veritable *Mud*way by manufacturers' refuse. I recollect the

local authority requiring the manufacturer who fouled that river, to take the refuse out of the river and put it into the sewer. Then it became a very difficult matter to deal with at the sewage works. The river was improved, but the sewage works were not, and for years it was a matter of considerable trouble to me and expense to the Corporation of Maidstone. I tried to make myself fully acquainted in every way with the different systems of treatment of sewage, so that I could, if possible, devise some means by which we could retain the improved condition of the river and yet get rid of our difficulties at the sewage works, at a reasonable cost and with some satisfactory results. But I had to give it up ; I had to leave the place before I had solved the question, and a few months before I left, the Corporation insisted upon the manufacturers taking their refuse out of the sewer and turning it again into the river. Then the Rivers Commissioners were down on the track of the manufacturers, and they were required to deal with their refuse in such a way that the river should not be fouled to any great extent. They were compelled to use the best available means for taking the most obnoxious matter out of their refuse. It put them to such a great expense that it ultimately smashed up the concern. An industry which employed between three and four hundred hands was eventually closed, but it has recently been reopened under other circumstances. What they are doing now I cannot say. It appears to me there are two difficulties in the way in dealing with this matter. First of all there is the difficulty that local authorities experience in getting a sufficient quantity of land whereon to deal with their sewage, and I do think it is the duty of Parliament in some way or other to give greater facilities to local authorities for obtaining the necessary land. Then I also recognise the difficulty that manufacturers have, and I agree with those speakers who have said that if the manufacturers are not allowed to turn their refuse into the sewer on the one hand or the river on the other, it means closing their factories altogether; that is only a natural result. But I think at the same time it is necessary that manufacturers should be compelled to do equally as much in the purification of their refuse as local authorities are in dealing with their sewage, by adopting the really best known available means. I think, also, that manufacturers should be—and I have no doubt they will be in future—called upon to so treat their refuse as to render it harmless. I believe, too, that by the aid of the chemists and engineers combined, it will be possible for manufacturers, as a rule,

to take out from their refuse those waste products which are causing so much expense at the present time, and use them or utilise them in some profitable manner. I believe that will be the result if pressure is put upon them. At the same time, I agree that powers should be given to local authorities by which they should be able to obtain land upon more reasonable and easy terms than at the present time. It is one of those difficult nuts that have to be cracked at the present day. I am one of those who think that the rivers ought not to be fouled at all; I am one of those who think that it is a wilful wicked waste for us to throw so much valuable material into the rivers and into the sea as we are doing at the present time, and I believe that those who come after us will certainly not call us wise, even because I think our successors will find some means by which that which we throw into the sea and the rivers, polluting the water and impoverishing the land, may be returned to and become of value to the land. I believe some means will be devised, by which all fæcal matter and urine will be, as I have said, retained and returned to the land, and I am not quite sure that electricity will not be the power that those who come after us will use for that purpose. I wish to add my thanks to Professor Robinson for his admirable paper, and I hope at some future time we shall be able to deal with this question at some special meeting, when we shall be able to give it more consideration and fuller justice than we have done to-day.

Professor Robinson: I thank you very much for the way in which you have received this paper, and I am glad to think that its brevity has commended itself to your good opinion. I am quite aware that the part relating to the refuse of manufactories is that which is likely to give the greatest difficulty, and I can quite appreciate the position of those in this room who are acting for manufacturing towns. They have to exercise the wise discretion of saying nothing, instead of saying something that may commit them with their authorities. In my paper I referred to the desirability of dealing with refuse by means different from those which have obtained in the past. I do not come here, amongst a gathering of practical men, to reiterate what every one knows has been done up to the present time, but there are remedies which are now under investigation, that in my opinion—I am very strongly of opinion on this point—will in the future provide a means of lessening the difficulties of manufacturers in this matter. I have now under investigation two methods of dealing with manufacturers' refuse.

One place especially I have in my mind, and I hoped I should have been able to include some data on the subject in my paper, but it was not received in time. I do not wish to suggest that any manufacturer should be driven to move elsewhere by reason of a system being enforced which is arbitrary and unnecessary. That is the argument, of course, that has been used for the last thirty years by those who will not do anything. I do not wish to force it home to that extent, but I am perfectly clear in my opinion that a vast number of sources of pollution from manufactories are easily capable of being remedied. As regards the refuse of farmsteads, you will find a number of small watercourses, which in dry weather would never be noticed as watercourses, bringing down refuse from piggeries and farmyards. These small foul tributaries to streams abound all over the country and admit of very easy abatement. With regard to the remarks of Mr. Cox, I have a case in my mind of a manufacturer who had been in the habit for many years of sending his refuse into a sewer, and he was called upon to abate this; and I have before me now the methods he pursued, which show that he has been able to extract from the waste products of his manufactory enough to pay for the little plant that he put down, thus removing what was formerly a source of mischief and annoyance. When he approached the subject he was under the impression that he was going to be heavily handicapped, but the result proved differently. Where solid organic matter is discharged into streams it deposits, and has not the help of the bacteria and plant life to purify it; whereas any dissolved impurity is more likely to become oxidised than the suspended matter, which goes to the bottom and remains there putrefying, until it eventually comes up in the form of foul gases. I do not think it is necessary to deal with the speakers in detail, because they may be summed up under two heads: those who think I have written a good paper, and those who fear I am trying to force home remedies in manufacturing districts which would be to the injury of the trade of those districts. That is not my wish at all. As regards the Bills before Parliament, the Rivers Pollution Bill was read a second time in the Commons last week, but it may not pass in the present session, for we all know the position such Bills are in just now. The Bill, however, is very influentially backed, and as it passed the second reading last week, there is no reasonable doubt that it will become law in a year or so. The other Bill has more to do with the removal of obstructions, and the

improvement of watercourses by enabling County Councils to cleanse them. The Rivers Pollution Bill is really the outcome of a great many years of thought and experience, and with the exception of that clause which I have pointed out in my paper, I do not suppose any material alteration will be made in it. Therefore it behoves all of you to look forward to the immediate future, when some steps will have to be taken to remedy the present pollution of the rivers.

THE DISPOSAL OR UTILISATION OF THE RESIDUE FROM TOWNS' REFUSE DESTRUCTORS.

By H. PERCY BOULNOIS, M. Inst. C.E.,
City Engineer of Liverpool.

Many papers have been given and books written upon the subject of house refuse destruction, and incidentally the questions of the disposal of the ashes and clinkers have been mentioned, but at the request of the President, the Author proposes to submit a few remarks upon the question of the disposal of the waste products which emerge from the furnaces of the destructor.

It has been found that the amount of fine ash and clinker which is left after the refuse has been passed through the fires averages from 22 to 33 per cent., but it may be safe to assume that with an ordinary refuse destructor there will remain 8 to 9 per cent. of fine ash, and 17 to 18 per cent. of hard clinker. These amounts, however, vary not only in every town according to the habits of the people and the quantity of trade refuse treated in the destructor, but also according to the time of year, the amount of coal consumed in the domestic fires, and whether there is a large proportion of vegetable matter in the refuse. The question is also affected by the length of time the house refuse is allowed to remain in the ashpit, and further, the condition of the refuse varies according to the state of the weather. In addition to this, the amount of the residuum is regulated by the heat in the furnaces, according to the fierceness or otherwise of the fires, this condition being almost entirely a question of construction or of forced draught. It must, however, be borne in mind that the word "destruction" is an incorrect appellation, the fact being that the material is subjected to fire, which disposes of the moisture in the form of steam and converts the organic matter into various gases.

In a well conducted refuse destructor, the residuum consists of a fine ash and a hard cinder or clinker, which is fused more or less together according to the heat to which it has been subjected.

The question of the disposal of this residuum is important, as bearing upon the cost of the so-called "destruction" of the house refuse, as up till now, in nearly all cases, it has had to be treated as a waste product which requires to be either carted or barged away as a useless material.

This material has been, however, used in some cases for filling in of pits, old quarries, or depressions in suburban districts, and the hard clinker is somewhat extensively used for bottoming macadamised roads; in other instances it has to be taken away in steam hopper barges and discharged at sea in deep water. Another method for its disposal is that of breaking and sifting the clinker and using it, after having had mixed with it a certain proportion of the fine ash, upon suburban footpaths for the purpose of making "cinder" footwalks, but these paths are seldom very satisfactory, as they are apt to become muddy in Winter and dusty in Summer. The fine ash may be used in certain cases as a cushion bed to receive paving sets in streets, but necessarily this method of dealing with it only disposes of a very small quantity. Another use to which it is almost universally put, is that of mixing the clinker with lime, placing the mixture in a pug mill with water, and thus manufacturing lime mortar. Owing to the porous nature of the material, the mortar thus made is extremely tenacious and hard when set, and is very useful for bedding flagging, and in fact for any other purposes where lime mortar is required.

The clinker can also be used for making concrete in the usual way, especially if it be broken into suitable sizes and mixed with Portland cement in the ordinary manner, and this method of disposal has been extensively adopted in all refuse destructor installations, where foundations, walls, steps, and even buildings, may be seen constructed of clinker concrete.

In connection with some investigations recently conducted by the Author on the question of the utilisation of clinker, he had occasion to consult the analyst for the City of Liverpool and County of Lancaster (Professor J. Campbell Brown, D.Sc.), and the following extract from a communication on this subject received from that gentleman by the Author, clearly defines the practical uses to which this material can be applied:—

> "I find that the sample of refuse destructor clinker "consists of 74 per cent. slag and other matters insoluble in "hydrochloric acid. The portion soluble in hydrochloric "acid consists of silicate of alumina, lime, and magnesia

"and iron, with a little sulphate and a considerable proportion
"of finely divided and diffused metallic iron.
"It is useless for any purpose except—
"(1) Road making.
"(2) Packing between sleepers on railways.
"(3) Grinding for use in cement.
"For these purposes it seems to be adapted.

"(Signed) J. Campbell Brown."

With regard to the ashes, the Author has found them to be most useful for mixing with the heavy clay soil of one of the Sewage farms under his charge, and he also believes that these ashes, if mixed with brick earth or clay, would greatly improve the quality of ordinary bricks, both in colour and hardness, and he is at present engaged in carrying out some experiments on these lines.

Another method for the utilisation of the clinker which is becoming more universal, is that of the manufacture of flagging for footwalks. In this case the clinker may be broken to suitable sizes, and made into Portland cement concrete in the usual manner, and laid *in situ* upon the footwalk about 3 or 4 inches in thickness, and trowelled up to a face, taking care to lay the concrete in alternate bays of not more than 6 feet in width, to prevent upheaval and cracking, which is so disastrous to monolith concrete of large unbroken area.

Another plan is to make clinker concrete in the ordinary manner and place it in iron-lined moulds of suitable dimensions, ramming the concrete by hand punners into the moulds, and when the concrete is sufficiently set, removing the sides of the mould and stacking the slabs until they are sufficiently hard to lay upon the paths, usually from six to nine months after manufacture.

This method requires a considerable amount of plant in the way of moulds, and the Author will now proceed to explain the manner in which he is now dealing with the clinker and ashes produced from a 24-cell destructor erected by him in Liverpool, and of which he has charge. This installation consists of twenty-four cells constructed on the "Fryer" principle, built back to back on each side of the tipping platform, which is approached by an inclined double roadway at a gradient of 1 in 16. A very large proportion of the material dealt with by this destructor is light trade refuse, and consequently upwards of 4500 tons of fine ash, and 9500 tons of clinker are made annually from a total of about 49,000 tons of house

and trade refuse disposed of at this destructor. The destructor is situated in the centre of Liverpool, and experience has shown that although the clinker and ashes are offered free to any one who will cart them away, scarcely any advantage is taken of this offer. The site of the destructor abuts on a branch of the Leeds and Liverpool Canal, and is so restricted in area that there is little or no storage room, consequently the bulk of the clinker and ash is put direct into specially constructed iron tank barges each holding about 48 tons, and by these barges taken to a screw steam hopper barge of 380 tons, where the tanks are lifted and emptied into the steam hopper barge, which proceeds about twenty-two miles out to sea and discharges her contents into deep water. The total cost of this disposal reaches about 2*s.* per ton, which of course adds considerably to the cost of burning the refuse, and in order to reduce some of this expense, the Author has manufactured and sold lime mortar; and more recently he has introduced a method of making clinker concrete flags under hydraulic pressure, which has been very successful, and the method of this manufacture he will now proceed to describe.

The plant, which has been patented by Messrs. Musker of Liverpool, consists of a hydraulic press or "ram," shown on the drawing and by photographs which the Author produces. The pressure for this ram is obtained from the Liverpool Hydraulic Power Company, who give a pressure in their mains of 750 lbs. on the square inch, which is used for the moving operations; but for the final pressure an "intensifier" has been introduced between the main and the press which raises this pressure so that the final pressing operations reach a pressure of 2¼ tons on the square inch. The clinker is broken in a small crusher worked by the engine supplied with steam by the destructor, to about ⅜ths of an inch size, and this is mixed by hand on an ordinary banker in the proportions of one part of cement to three parts of broken clinker, the compo being mixed very wet.

The frame in which the mould is placed works in a horizontal direction, upon the rails supporting the frame, by hydraulic pressure, and the mould is filled with the compo when it is outside the press, a pad being placed at the bottom of the mould, composed of a perforated zinc plate covered with thick insertion. When the man (who is filling) has screeded off the top of the mould, he places a felt pad over the mould, pulls a lever, and the frame passes into and under the head of the press. By means of another lever he

raises the mould and frame right under the fixed head of the press; and by a third movement he brings the whole pressure from the ram directly upon the slab.

This pressure is allowed to continue for about a minute, when water from the compo ceases to flow, and it may be observed that owing to the pads no cement comes out with this water. The pressure is then relieved, the frame is allowed to drop and then withdrawn by hydraulic pressure outside the press.

Underneath, and level with the ground, a movable platform is provided which is worked vertically by hydraulic pressure. Upon this platform a small trolly is run, having had previously placed upon it a movable flat board provided with handles, and upon this board the slab is received. In the meantime the frame containing the mould and slab is turned over and the platform lifted, which brings the flat board already referred to close up under the slab, and by turning a handle, the nuts pressing against the heavy false bottom or die at the bottom of the mould are slackened, which then falls and pushes out the slab in the mould ; and consequently, when the platform is lowered the slab comes out with it, and is wheeled off on the trolly and carried on the flat board in question by two men to a suitable position, where the slab is allowed to ripen for a couple of days and is then up-ended.

The number of men employed is as follows. A lad works the lever handles, fills in and screens the compo in the mould, and three men manufacture the concrete and pack the slabs.

About 45 yards of slabs are manufactured per diem, the cost being as follows:—

Cost of Manufacture of One Yard of Clinker Concrete Flagging, 2½ inches Thick.

Material.	Cost.	Remarks.
65 lbs. of Portland cement ..	10¾*d.*	Varies with cost of cement.
152 „ of clinker	nil.	Really a saving of 1¾*d.*
Water	¼*d.*	This item could be dispensed with where pressure is obtained by using steam power of destructor.
Labour	5½*d.*	
Plant, contingencies and supervision.	3¼*d.*	
Total cost per yard	1*s.* 7¾*d.*	

The total cost of manufacture is thus about 1*s.* 7¾*d.* per square yard, without reckoning the saving in using the clinkers. The sizes of the slabs that are made are 2 feet × 2 feet, 2½ feet × 2 feet, and 3 feet × 2 feet, each being 2½ inches in thickness.

The Author produces some samples of slabs which have been made in this manner. Some of these slabs have been laid twelve months, and show no sign of wear, but sufficient time has not yet elapsed for the Author to say whether they will last as long as Yorkshire or other natural stones; but from the experience he has already gained, he is of opinion that this class of flag will have a life as long, if not longer, than Yorkshire flags, and owing to the porous material with which they are made, the clinker paving slabs have a foothold much better than the natural stones. Their colour is rather dark, but this slight objection may be obviated by painting the flags, after they have been laid, with a mixture of cement and water, which takes some time to wear off.

Tests of Machine-Made Clinker Concrete Flags, 2½ inches in Thickness.

Age of Flag.	Breaking Load applied at centre of Flag.	Age of Flag.	Breaking Load applied at centre of Flag.
4 months.	1804 lbs.	6 months.	2061 lbs.
4 „	1474 „	6 „	1966 „
4 „	1742 „	4 „	1859 „
4 „	1917 „	4 „	1659 „
4 „	1608 „	4 „	1589 „
4 „	1752 „		

The preceding table gives some tests of these slabs which have been made quite recently, and when the youthful age of the slabs is taken into account, they may be considered very satisfactory.

The total cost of the machinery as supplied and fixed by Messrs. Musker was 1275*l.*, the foundations and necessary plant cost 225*l.*, exclusive of the clinker crusher, which cost 45*l.*, making a total for the whole installation of 1545*l.*

In conclusion, the Author is of opinion that the use of these waste products of waste products can be carried out with economy and utility, and although the quantity of clinker and fine ash in any town where destructors are at work would be largely in excess

of the amount that could be utilised for this purpose, it is evident that any use to which these materials can be put must necessarily be of considerable advantage, and tend to lower the initial cost of the disposal of house refuse by the process of burning.

DISCUSSION.

The PRESIDENT: This is a very interesting paper and one that deals with an important subject. Mr. Boulnois describes it as dealing with "the waste products of waste products," and I think that is a very apt description. We all know what difficulty we have in dealing with the waste products from the house refuse of towns, and we also find that after we have reduced its quantity and altered its character, there is still a waste product which we do not know how to dispose of with advantage. Mr. Boulnois appears to have gone a little in advance of most of us. He has utilised the clinker for the manufacture of paving slabs and so on, and in a cheaper way than has been hitherto done. We all know the way to make paving stones of clinkers; it has been done over and over again at various places, but I think Liverpool is the first place where hydraulic machinery for pressing the slabs has been used. The paper gives satisfactory results as to the cost, and I have no doubt there are many here who would like to question Mr. Price on the subject, with a view to elicit still further information on this interesting subject, as Mr. Price has kindly undertaken to represent Mr. Boulnois on this occasion in his unavoidable absence.

Mr. T. DE COURCY MEADE said he had the opportunity of seeing the machine described at work at the Corporation Yard, Liverpool, and it then appeared to be acting well. He had some time ago experimented in the construction of street paving with destructor refuse instead of crushed stone. A model plant had been lent him for that purpose, and the slabs were made under pressure; the result was very satisfactory. He thought that the extraction of the water from the slabs by pressure was a great advantage; it certainly caused an immediate hardening of the slabs, and he believed that it would lead to their ultimate hardness and durability.

Mr. YABBICOM: I had an opportunity some time ago of seeing this machinery at Liverpool, and was very much pleased with the work that it did, so much so, that I advised my Council to put up a similar apparatus in Bristol. They were willing to do so, and we obtained the consent of the Local Government Board to borrow the money to allow us to carry out the scheme, and I hope that at no distant time we shall do so. The slabs that I saw turned out at Liverpool, which I think were not so good as the sample on the table, gave one the impression of being rather rough on the surface. They certainly give a firmer foothold for that reason, but they do not present the pleasing appearance of a concrete pavement worked up by the hand. At the same time it must be a very great advantage to reduce the amount of water left in the slab, and the permanent wear I should think would be very great. There is another company in South Wales at present manufacturing slabs from crushed granite under pressure, and I think the pressure employed is very much greater than in the machine illustrated here for the purpose of manufacturing slabs from destructor clinker. Anything which can give us a chance of utilising the products from a destructor, and especially at such an economical rate as is being done at Liverpool, must be a very great advance. From 30 to 40 per cent. of residue is simply the ordinary return, and although only a very small proportion of that can be utilised for laying down in the streets, yet any apparatus capable of producing from it a material which may be of permanent use, is a very great advantage, and one to be encouraged. Certainly the results of that machine which I saw myself at work were very satisfactory.

Mr. LOWE: I have been making clinker pavements for the last eight years, and have used no press of any kind. It has been simply made, shaken down and hand trowelled, and the proportion of cement used has been as 1 to 3. I have also laid some *in situ* on the footways; I inspected it yesterday, and it looks as good as when it was put down. I think there is a very wide field for those who have destructors to use up their waste products in this way. I agree with the Author of the paper as to the results. I obtained about the same amount of fine ash from the burning. The builders will take the fine ash free; they will not pay you anything for it. The hard core is more difficult to deal with. If your roads are already made you cannot use it for your foundations, it has either to

be carted or barged away. I think, therefore, that the utilisation of waste products is worthy of the consideration of all those who anticipate erecting destructors. During the last seven or eight years we have disposed of between 24,000 and 25,000 tons of refuse a year. The slabs made will not of course compare with Victoria stone or some other patent stones, but it is a durable material, and takes the place of the gravel or hoggin paths in front of suburban properties.

Mr. Bennett: I think the apparatus shows a means of getting rid of the waste products of this country, and having been a maker of these slabs in the town I represent for something like ten years, I can fully bear out the statement of the last speaker that these slabs, if properly made, wear exceedingly well. The Author says that "some slabs made twelve months ago show no signs of wear, but time will show whether they will last as long as Yorkshire or other natural stones." I question whether the ordinary clinker-made slab will last as long as the natural stone. I have made slabs from clinkers, and they have lasted and worn very well for ten years. What we did in our case was this. We took the crockery from the refuse, smashed it up and faced the slabs with it. It gave them a very pleasing look, a kind of mosaic appearance. It is not necessary to resort to painting in this case, unless you want artistic designs for your foot-walks. I can fully bear out the Author of the paper when he says that this pavement has a good foothold. With regard to the wear, we put down at the same time some cast-iron footpath gutters, and if you look at that pavement to-day you will find no difference between the surface of the slabs and the cast iron, and it may last, perhaps for ten years more. I appreciate this paper because I think it is a move in the right direction.

Mr. J. A. Crowther: I have been very much interested in the paper, and have felt, like many of my confrères, the difficulty of getting rid of the residue from the dust destructors. I have got a press at work which has been working satisfactorily for some four or five months. Our object, of course, after passing the refuse through the fires, is to get rid of the residue. I find from experience that we can, working continuously with a plant similar to that Mr. Boulnois has, get rid of about 20 tons of clinker per week. Take a destructor of twelve cells. It will consume from 6 to 8 tons per day per cell. We will take the mean, 7 tons per day, that is 84 tons for the twelve cells. One-third of that comes

out as clinker, that is approximately 28 tons, and in the week that gives us a quantity of 168 tons of residue. With one of these presses you can use 20 tons; the remainder, of course, can go, as the Author of the paper suggests, for foundations of roads and so forth. I should have liked to ask, if Mr. Boulnois had been present, whether this cost of 1*s.* 7¾*d.* includes everything or not. My cost comes out slightly above that. Then, again, I should like to know how the tests have been carried out. I had some of these flags broken which had been stored for three months. I do not know whether my system of testing was defective or not, and if the Members of this Association think I am in the wrong I shall be only too glad to be corrected. I will explain how I carried out the tests. I took each flag and tested it, practically as one would a beam, to see what it would carry. I found that one flag 3 × 2 feet, and 2¼ inches thick, supported 2 feet in the clear, and bedded on felt carried 1316 lbs. for fifteen seconds and then broke. I may explain that I put 7 cwt. on the flag, and then added 56 lbs. every thirty seconds till the fracture took place. I conducted the second experiment in the same way, and that bore 1372 lbs.; the third 1540 lbs.; and the fifth 1260, the latter for twenty seconds. I have worked these breaking weights out, using the formula $C = \frac{B\,W \times L}{B\,D^2}$, and find that the averages give 22·86 as a constant. These results are very different from those given in the paper, but that may be accounted for by the different system of carrying out the test. Moreover, I see that Mr. Boulnois broke his flags after six months and four months; mine were broken at the end of three months. In order to test the real value of these flags and to get some idea of their strength, I tried to break an ordinary 3-inch second barnes Haslingden flag, a stone very much like Yorkshire—in fact so much so, that though I have been mixed up with the trade all my life, I cannot tell the difference between ordinary samples of these stones—and I found that it stood 3200 lbs. for fifteen minutes without a fracture. I did not wait long enough for it to break.

Mr. Paton: With regard to use of artificial stones generally, I find in them a liability to crack, and certainly a very large percentage of these stones do fracture. I should like to know whether the period of trial has been sufficiently extended to enable Mr. Boulnois and Mr. Price to say whether they have found fracture take place to any extent. Mr. Bennett says that he has used this

kind of stone, and I should like to ask him whether he found the rate of wear was uniform.

Mr. Blair: Wherever destructors are used we have such a quantity of clinker produced that we cannot use it all, and many of us cannot even give it away, in fact, we have to pay for its removal. Mr. Lowe is in a position to give away a lot of his fine ash, while I have to pay for mine to be taken away, no new roads being required, as the district is completely built up. I have therefore endeavoured to find other methods of treating this fine ash and clinker and to show whether it would compare favourably with other material, I made briquettes of cement composition, using in some the most suitable clean sand, and compared them with cement briquettes made of fine ash or of crushed clinker. One might naturally expect to find that the selected sand would give better results than the briquettes made of this composition from the fine ash, and I was surprised to find that it was otherwise. The result upon briquettes of 1 square inch section, in which the proportion was 3 to 1 of fine ash and cement, at three months was 204 lbs. breaking strain, and in the case of the briquette made of the best sand obtainable for the purpose, 179·5 lbs. The ordinary Thames sand, which is very largely used in London, dropped down to about 46 lbs. So that you see the cement composition made of the fine ash of the destructor furnace was better than that made from the best sand obtainable. It was the same with concrete. I had some concrete blocks made for testing purposes. The first lot of blocks—12-inch cubes—were intended to be mixed 6 to 1, but by some mischance we got a mistake in the proportions and they were only actually mixed 5 to 1. It was a miscalculation in the gauge boxes. The blocks made of clinker taken from the furnace mouth, containing tins and all classes of fine material, mixed in the proportion of 5 to 1 with cement, broke at the age of three months under a crushing weight of 55·6 tons. Rough Thames ballast containing stone from two inches diameter down to sand, mixed in the same proportions and at the same age, broke at 45·2 tons, and fine Thames ballast containing pebbles from $\frac{3}{4}$ inch down to sand, broke at 23·7 tons, so that in that case also the concrete made of the clinker just as it came from the furnace mouth—not selected, not even riddled—gave the best results. There is one other residual that I have been trying experiments with, and I believe others have also tried to make use of it, namely, the flue dust. I

am able to give it away, but I can get nothing for it, and it occurred to me that it would be easy to convert this fine dust into carbolic powder. A sample was examined by a firm of manufacturers, who reported that they thought it was very suitable, and if I liked they would make me some carbolic powder from this dust, employing the same proportion of acid as in the ordinary 15 per cent. powder. They made it up and sent me a sample, which they could sell at 25*s.* per ton less than the ordinary powder of commerce. I am having it examined by other firms with the object of seeing if I cannot get it prepared at even a lower price than that. I was glad to hear Mr. Yabbicom refer to the proportion of residuals, and he mentioned that there were between 30 and 40 per cent. There is undoubtedly a great deal of misapprehension as to what is the proportion of residuals that may be reasonably expected from destructor furnaces. It is commonly stated to be 25 per cent., and sometimes as high as 33 per cent. This is the range usually adopted by patentees of furnaces, and often given in returns as estimated proportions, but it is very difficult to get the figures from weights taken at the works, showing what these residuals do actually amount to. I have obtained some results from a few large works—which I will not name for obvious reasons—and the amount is very much higher indeed than 25 to 33 per cent. It may surprise you to learn that in the case of one well-known destructor the actual weights taken on their own machine show a total of residuals of equal to 44 per cent. of all that came in. Of course these figures vary with the nature of the material. Those who get heavy mineral matter will naturally show a higher proportion than those who get light shop refuse—paper, vegetable matter and such like. Vegetable matter, which contains a lot of water and therefore weighs heavy, can be burnt down to next door to nothing, and where this is abundant they get a small proportion of residuum; but I am afraid that it is in very few places indeed that anything like a quarter or a third actually represents the amount of the residuals. It is not so in the case of my own furnace, and I tell you without hesitation. For the period of a month, all the material of all descriptions that came in was weighed, and all that went out was weighed, and the result proved that the residuum was 36 per cent. It is very difficult to get these figures very accurately, because you may have a stock of one thing or another at one end of the month—either the beginning or the end—that upsets your total, but I got right at both

ends, that is, with a clear yard, and the result proved to be 36 per cent. Of course it can be reduced, if you are not particularly anxious to force a lot of material through your furnaces. One gentleman, well known to most of us, once told me that he did not care how little material he burnt so long as he burnt it well. If we were in that position and not bound to force our fires, we could reduce the residuum to a very low proportion; but if we are anxious to get rid of as much stuff as we can with as few fires as possible, we must look for a much higher proportion of residuals.

Mr. Cox said: Having had charge of four destructors comprising thirty-five cells for many years, I have had opportunities of ascertaining the amount of reduction of refuse by burning, and I have found that the material is reduced in bulk to one-fourth and in weight to one-third. I have no doubt that something is due to the temperature you get in these destructors. We have no difficulty in getting as high as 1500°, and I should expect getting better results in the way of more perfect combustion with a higher temperature. I have also had the flue dust analysed, and I found there was very little nitrogenous matter in it; in fact it was not worth naming as to its value for manurial purposes. It was only ·023 per cent., but the analyst said it might be useful to manure manufacturers for some of their preparations which required an absorbent. At one depôt, where we have twelve cells burning 24,000 loads in a year, we have, roughly speaking, about 6000 loads of clinker, and 2000 loads of this we make into mortar. Being in a flag-stone district, we have not gone fully into the question of providing machinery for slab making, but I have found a very good outlet for the material in putting up crushing and screening machinery. We crush the clinker and screen it into various sizes, and I have an idea of using it for making common asphalt by mixing it with pitch and tar, and using it on the suburban foot-walks. But there has been such a demand for the screened clinker by contractors to make concrete, mortar and plaster, that I have not been able to secure a load yet. But I expect in the winter months there will be a lull in that direction, and then we shall be able to store up large quantities for laying asphalt footways.

Mr. J. Patten Barber: With regard to the testing of these slabs, I think the result depends upon the way in which the load is applied and the way the flags are supported. In giving figures relating to the breaking stress of a flag or anything else, it is

necessary that the methods in which the loads are applied, the manner in which the weights are placed, and the mode by which the slabs or beams are supported, should be stated. Otherwise we cannot possibly compare results. Unless the loads referred to in the paper were applied in a similar manner to those applied by Mr. Crowther, and unless the slabs were supported in a similar manner, we cannot compare the different results. I would suggest that it would be very useful if these particulars could be furnished; but personally I do not think that a load applied by placing weights on the centre of the flag would be of very much use to us in judging the stress that a flag would bear. I would suggest that it would be very much better if the flag were supported on narrow bearings and then covered by a water-tight box, and the water added gradually, so that we could get an absolutely equally distributed load over the whole of the flag; or that a beam of specific size and length should be made, and supported on a narrow bearing surface, and the weight gradually applied, either as a distributed load or as a central load, across the entire central width of the beam, until signs of failure appear. A modulus of rupture could thus be obtained by experimenting upon a number of similar beams, and this would, perhaps, be the most useful and reliable information as to the strength of slabs. But it is useless comparing results unless we know that the experiments by which the results were obtained were carried out in precisely the same manner. Otherwise we get figures which vary very much and which are not of much service to us.

Mr. T. W. Stainthorpe: I notice it is stated in the Author's paper that at Liverpool their refuse is carried eighteen miles out to sea. I come from a large iron manufacturing district on the north-east coast of Yorkshire, where many thousands of tons of refuse are carried out to sea every year, and deposited within four miles of high-water mark. It seems strange to me that they should have to take their refuse fourteen miles further out on the west coast than they do on the north-east. I should like to know if they are legally compelled to do this, and if so, why?

The President: I have to say that I am a learner on this question. I have had no experience to which I can refer, and therefore I will not take up your time with any remarks, but pass on to ask Mr. Price to answer your questions. We started our destructor here in May. Up to the present time our working has been what might be called a tentative work, just feeling our way

and seeing what will be the proper method of working, keeping accounts and getting experience. I have laid down certain regulations which will come into operation on July 1, and I hope that our observations will be taken so carefully and so fully that at some future date they may be of some service to the Association. I am sure you will all agree with me in thanking Mr. Boulnois for this valuable paper, which has created such an interesting discussion, and Mr. Price for the further information he has added verbally.

Mr. J. PRICE: I labour under some difficulties in replying to this discussion. In the first place, as was remarked by Mr. Meade, you will understand there are some points upon which we have to use discretion in any answers given. In the second place, I am not the Author of the paper. I will now take the questions in the order they were asked. I am pleased to say that some gentlemen who are familiar with the method of manufacturing concrete slabs, agree, and are satisfied with this method. There are certain questions arising as to the appearance of the flags. Well, the appearance of the flag is to a certain extent against it, and in Liverpool we have painted the surface with a pretty strong mixture of Portland cement and water: that has two effects — of brightening the surface, and of filling in the interstices in the flags. Although no one has made mention of it, it is a fact that owing to the use of a pad there is a certain amount of peeling off the surface, and that is filled in by the cement mixture. Mr. Bennett also referred to the way he manufactured slabs, and he says they have given very good results. I have no doubt they have, because at Toxteth I have been manufacturing them for something like twelve years with good results. They have been used at Liverpool, where the painting has been found quite sufficient for the purpose. Mr. Crowther raises the point as to the amount of residuum used for this purpose, and states that it is only a small proportion of the whole. That is so, and must naturally be so, the output of residuum being very much larger than can possibly be used in any one town in street works. The amount used in Liverpool has really been very small. With regard to the flags laid down: in one district where there is a moderate amount of traffic, from my own observation there has been, in the twelve months they have been down, no depreciation that I can see. I cannot say that this is a fair trial, agreeing that until they have stood for at least ten years, you are not in a position to say it is absolutely a success in regard to wear. Speaking from my own

experience of this kind of flagging, I find that after twelve years there has not been more than about $\frac{1}{8}$ inch wear on flagging in crowded thoroughfares. There is one point raised as to the testing of these flags, and I am sorry to say I cannot answer the question. The tests were made before I was connected with the Corporation of Liverpool, and I have no details of them. I need hardly point out, however, that the age of the flag, the quality of the cement used, and a few other matters of that kind, are most material in the results, particularly the strength of the cement; when you have the proportion of diluents acknowledged by the trade, varying from 2 per cent. to something like 25 per cent., you can understand the difficulty of arriving at reliable results. Mr. Paton speaks about the liability of the flags to crack. I can only say that not a single flag has cracked in any case coming under my observation. In testing flags I should consider such a test as dropping a weight from a certain height on the flag laid across supports would be best, as I find that the damage is caused to the flags by throwing coals and weights of that kind upon them, and that if they are properly laid with a proper bearing, ordinary wear and tear has practically no effect upon them. Mr. Blair has given us some very good results. He generally does bring us some facts which are always useful. I have here a sample of mortar; this was made with fine ash from the destructor, and is a remarkably good sample. It was taken out of a wall erected nearly three years ago. That points very much to the same conclusion that Mr. Blair has already arrived at. Of course at Liverpool we use the residuals at our sewage farms, as we have many miles of roads there, and the very fine ash is ploughed into heavy land to lighten the soil. In fact we have to employ every possible means, at very considerable cost, in getting rid of the refuse and also of the residuals from the destructors, and every small quantity that disappears is a help. As to the reduction in bulk, that of course depends very much on the character of the refuse. In some parts of England coal is very cheap and it does not pay to save, and therefore you get in the refuse a very large amount of unconsumed combustible matter, and that makes a great difference in the burning, and the results of the burning. With the destructor at Toxteth, working in a somewhat similar manner to that of Mr. Blair's we get a reduction to something like 30 per cent., burning about 6 tons per cell per day. When you go beyond that point you very considerably increase the amount of residual, showing that you have not com-

pletely burnt out the whole of the combustible matter. As to the question of cost of the plant for manufacturing flags, no one has raised the point. The cost of the machinery is 1275*l.*, the foundation and plant cost 225*l.*, and the clinker crusher 45*l.*, making a total of 1545*l.* I may say that the plant takes up very little room and can be used in a very small space.

HOUSING OF THE WORKING CLASSES.

MODEL COTTAGES, TENEMENT DWELLINGS, AND MUNICIPAL LODGING HOUSES.

By J. H. BRIERLEY, Borough Surveyor, Richmond, Surrey.

The question of providing sanitary dwellings, and of improving the surroundings of the homes of the great working-class population of this country, has exercised the minds of a large section of the public and the legislature for something like half a century, and much useful work in this direction has been carried out, but much still remains to be done.

During the forty years preceding the passing of the "Housing of the Working Classes Act, 1890," much of the work carried out, except in certain of the larger towns, with a view of improving the conditions under which the labouring classes were housed, appears rather to have been due to the munificence and enterprise of private individuals than to the action of the local authorities.

Several measures dealing with the subject passed into law during the above-mentioned period, Lord Shaftesbury, Mr. Torrens, and Sir Richard Cross having each in turn introduced Bills with a view of improving the existing state of affairs, which ultimately in amended form became law; in fact, prior to the passing of the Act of 1890, the general law relating to the housing of the working classes, apart from the powers conferred by the Public Health Acts, the Nuisances Removal Acts, and the Metropolis Management Acts, was practically contained in the following Acts.

1. "The Labouring Classes' Lodging Houses Acts, 1851 to 1867," commonly known as "Shaftesbury's Acts," which enabled urban and rural authorities to borrow money for the provision, by erection, purchase or lease, of lodging houses for the working classes.

2. "The Artisans' Dwellings Acts, 1868 to 1882," commonly known as "Torrens' Acts," which empowered urban authorities to take proceedings for securing the improvement or demolition of

houses unfit for human habitation, and also to deal with buildings which, although not in themselves unfit for habitation, were by reason of their situation in regard to other buildings, obstructive to ventilation or conduced to make surrounding buildings unfit for human habitation.

3. "The Artisans' and Labourers' Dwellings Improvement Acts, 1875 to 1885," commonly known as "Cross's Acts," which enabled urban authorities to carry out improvement schemes for the reconstruction and rearrangement of unhealthy areas.

Although much good work in clearing unhealthy areas and erecting improved dwellings in place of those demolished was done in London and other cities, and some of the larger towns, under the above Acts, their intricacies and the tedious legal formalities to be gone through, added to the cost of putting them in force, militated very strongly against their general adoption, and notwithstanding the fact that the Local Government Board endeavoured from time to time to stir up the local authorities by means of strongly worded circulars, calling attention to the great and pressing question of the housing of the labouring classes, and also pointing out the duties imposed and the powers conferred upon such authorities by the existing Acts, very little was done, and it was not until the two Bills introduced by Mr. Ritchie, the then President of the Local Government Board, one to amend and the other to consolidate the existing Acts, were finally entered on the Statute Book, as the "Housing of the Working Classes Act, 1890," that local authorities set to work in earnest to deal with the question.

A large number of local authorities have, with commendable enterprise and activity, since the passing of that Act, made strong efforts in the direction of improving the homes of the poor, and in consequence many important schemes have been carried out.

The reason of this is not far to seek, for whereas prior to the passing of the Act of 1890 nothing could be done except at great cost and by tedious processes, that Act has so simplified matters by the consolidation and rearrangement of the previously existing laws, and by the additional facilities given for acquiring, without the payment of exorbitant compensation, unhealthy areas and insanitary dwellings, and carrying out schemes for the reconstruction and rearrangement of such dwellings and areas, that it is now possible for every urban authority to take up the question, and carry out improvement schemes dealing with unhealthy areas at a comparatively small annual addition to the rates, and for every

urban and rural authority to close or otherwise deal with unhealthy dwellings, and to provide additional sanitary dwellings in place of the dens and hovels in which so many of the labouring-class population have hitherto been, and even now are, condemned to live.

The more important extensions and amendments of the previous Acts contained in the Act of 1890, may be summarised shortly as follows :—

Section 5 (2) and section 31 enable the inhabitants of a district to put the law in motion in default on the part of the local authority. In the case of an unhealthy area, twelve or more ratepayers, and in the case of a dwelling unfit for human habitation, any four or more ratepayers, may lodge a complaint in writing with the medical officer of health for the district, who must thereupon inspect the area or dwelling, and forward the complaint with his report to the authority. Should the local authority take no action, as to the preparation of an improvement scheme or closing order, as the case may be, the complainants may petition the Local Government Board for an inquiry, after which the Local Government Board may order the authority to take action in the matter. Sections 21 and 41 clearly lay down the principles on which compensation is to be paid : no allowance is to be made for compulsory purchase, nor in respect of improvements made after notice has been given of the carrying out of the Act. Deductions are to be made for an enhanced value by reason of the dwelling house being used for illegal purposes, or being so overcrowded as to be dangerous to the health of the inmates. The bad state of repair in which the premises are found is to be taken into account, and if the house is unfit for, and incapable of being rendered fit for, human habitation, the value of the land and of the materials thereon only are to be paid for.

Section 32 (3) provides that where a closing order has been made the local authority must give seven days' notice to the tenant of the dwelling, who is entitled by the court making the closing order to a reasonable allowance on account of his expenses in removing. The local authority may make a similar allowance to tenants whose houses are required for the purposes of an improvement scheme.

Section 67 provides that the Public Works Loan Commisioners may advance a loan to any company, society or association, established for the purpose of constructing or improving, or of facilitating

or encouraging the construction or improvement, of dwellings for the working classes.

Section 75 provides that in the letting of houses or parts of houses to the working classes, there shall be implied a condition that the house is at the commencement of the tenancy in all respects reasonably fit for human habitation. Many other important practical amendments might be mentioned, but the value of the increased powers conferred on local authorities is well known, and has already been fully proved by the numerous important schemes carried out since it became law.

Model Cottages.

A local authority having resolved that a certain area is an unhealthy area, and that an improvement scheme ought to be made, the question at once arises as to the class of dwelling to be erected in place of those to be demolished.

Unquestionably the ideal labourer's dwelling is the cottage house, with an open space in the front and at the rear; but it is extremely difficult in thickly populated centres, more especially in cities and the larger towns, to provide these, owing to the great price to be paid for land, at such a weekly rental as will bring the houses within the reach of those for whom they are primarily intended, and at the same time ensure an adequate return, sufficient to pay the working expenses and the instalments of the loan and sinking fund.

As Mr. Boulnois points out in his very interesting and instructive book, 'The Housing of the Labouring Classes, and Back to Back Houses,' it is the very poor for whom improved dwellings are most urgently required, and to deal satisfactorily with the question it is necessary that the rent should not exceed about 1*s.* per week per room; although, so far as the Author is at present aware, no authority has yet been able to let dwellings at this rent so as to secure a return sufficient to meet all charges. Many local authorities, however, have gone in more or less extensively for the erection of cottages, notably Liverpool, Manchester, Edinburgh, Birmingham, Huddersfield, Glasgow, Richmond, which are let at rents averaging about 1*s.* 6*d.* per room per week, and the County Council have also erected cottages at Deptford and Greenwich, but these latter of course approximate more nearly to 2*s.* 6*d.* per week per room.

It may be interesting to state what has been done in this direction at Richmond. The Town Council, having adopted Part 3 of the "Housing of the Working Classes Act, 1890," last year erected in a central position in the town 56 cottages, viz. 22 (class A), containing six rooms and scullery, with pantry, coal-store and water-closet at rear; 28 (class B) containing four rooms and scullery, with pantry, coal-store and water-closet at rear; and 6 two-story tenements (class C), referred to hereafter. The area of the site of class A cottages, which have a frontage of 17 feet 6 inches, is $54\frac{1}{3}$ square yards, exclusive of a 10-feet forecourt, and an average open space at the rear of 127 square yards; the cubical contents of each house being 11,679 cubic feet, and the cost of erection, exclusive of site and road-making, $5\frac{1}{2}d.$ per foot cube, equal to 252*l.* 3*s.* per house. The area of site of class B cottages, which have a frontage of 12 feet 6 inches, is 40 square yards, exclusive of a 10-feet forecourt and an open space at the rear of $123\frac{2}{3}$ square yards; the cubical contents of each house being 7965 cubic feet, and the cost of erection, exclusive of road-making and cost of site, being $5\frac{5}{8}d.$ per foot cube, equal to 186*l.* 3*s.* 9*d.* per house.

The scheme was designed by the Author's predecessor at Richmond, Mr. E. J. Lovegrove, engineer and surveyor, Hornsey, and the cottages have been carried out by the Author, with but slight variations from the original plans.

The six-roomed cottages (class A) are let at 8*s.* and 7*s.* 6*d.* per week, an extra 6*d.* per week being charged for the cottages in the front road. The four-roomed cottages (class B) are let at 6*s.* per week. Some particulars as to the cost of the scheme are given at the end of the paper.

There can be no question that the erection by a local authority of well designed and well constructed cottages is productive of much ultimate good, beyond the immediate physical benefit to the tenant, inasmuch as in many towns it is stated that the surrounding neighbourhoods have been found to be considerably improved thereby. Some small improvement usually follows in the condition of other dwellings belonging to private landlords.

The tenants themselves are subject to stringent rules (which can be carried out more efficiently by a local authority than by a company or individual) as to cleanliness, and which do not fail to gradually substitute cleanly for dirty habits.

It has been suggested by Mr. T. Wrightson, formerly M.P. for

Stockton, who introduced a Bill with the object in view, that municipalities shall lend money to working men desirous of purchasing their own houses, on similar lines to those adopted by the building and co-operative societies throughout the country. The local authorities would be able of course to offer better terms, and if the proposal be carried to a practical issue much good will undoubtedly result. The precarious nature of, and consequent frequent change of employment, would of course prevent the great mass from taking advantage of the benefits offered by such a measure, but the ever increasing number of cottages owned and occupied by the working men in the country, shows that where reasonable facilities exist for purchasing the houses they live in, they are not slow to avail themselves of such opportunities.

Tenement Dwellings.

Tenement houses have been described as "houses occupied at weekly rents by members of more than one family, but in which members of more than one family do not occupy a common room." Next to the cottage dwelling, the two-story tenement, having a self-contained house on the ground floor, with the necessary amount of open space at rear required by the model bye-laws of the Local Government Board, and a similar dwelling above, access to which is gained by a separate staircase, is the best form of dwelling; but again the cost of land frequently prevents the erection of this form of dwelling. It may be incidentally mentioned that in the Author's experience at Richmond, although the number of two-story tenements provided was only about one-tenth that of the ordinary cottages, there was nothing like the competition for admission to this class of dwelling as for the ordinary cottage. The two-story tenements erected at Richmond (class C) are built in two blocks of three each, the ground floor dwelling comprising living room, bedroom, scullery, pantry, and water-closet at rear; a self-contained house is provided on the upper floor, comprising living room, two bed-rooms, pantry, and water-closet at rear; a separate entrance and staircase is provided in front, and an iron staircase leads from a small landing or flat at the rear, to the garden which is equally divided, the floor of the upper tenement being of concrete carried on iron joists. The frontage of these tenements is 17 feet 6 inches, the area of the site is 54⅓ square yards, exclusive of a 10-feet fore-

court and an average open space at the rear of 127 square yards; the cubical contents of each tenement being 5892 cubic feet; the cost of each double tenement being 321*l.* 19*s.* 6*d.*, equal to 6½*d.* per foot cube, exclusive of road-making and sewers and cost of site. The upper tenements are let at 5*s.* 6*d.* per week, and those on the ground floor at 4*s.* 6*d.* per week.

Where the cost of land does not permit of the two-story tenement being erected, it of course becomes necessary to erect block dwellings three or more stories in height, but preferably not exceeding three stories. The London County Council have decided that the blocks to be erected by them shall not exceed five stories in height. In the larger towns extensive areas have been dealt with, and important blocks of dwellings of this class have been erected by the Corporations of Liverpool, Manchester, Edinburgh, Glasgow, Salford, Barrow-in-Furness and others. In some cases the whole of the ground floor has been devoted to shops, with living rooms attached, but this would seem to be rather a risky procedure. It is found that two or three-room tenements are in greatest demand, but single-room tenements are a necessity, and bed space should be arranged where a separate room is not provided.

It is necessary that through ventilation should be provided from front to back, and the arrangement of blocks in rows appears preferable to the quadrangular arrangement, and preferably the dwellings should be approached by open staircases dividing the tenements into blocks, corridors being as far as possible avoided. The tenements should as far as possible be self-contained; a wash-house may be used jointly by about half a dozen tenants, but the water-closets and sinks should not be used by more than two families, and then only in the case of single-room tenements. The roof may with advantage be flat, and the space so provided utilised as a playground for children and a drying ground for clothes. The building should be as far as possible fireproof.

Much adverse criticism has from time to time been heard with respect to block dwellings, which, it has been stated, have proved to be anything but healthy dwellings, but statistics do not bear out the allegations as to the higher death rate and greater prevalence of disease in this class of dwelling.

The vital statistics for the last three years as regards the dwellings erected under the Peabody Donation Fund, with a population of upwards of 19,500, show that the average birth rate during the year 1895 and the two preceding, was 36·1 per

thousand, or 6·4 higher than for the whole of London; the average death rate for the same period being 17·1 per thousand, or 2·5 lower than for the whole of London; the average rate of infant mortality for the same period being 126·5 per thousand births, or 19·9 lower than for the whole of London.

The Metropolitan Association for Improving the Dwellings of the Industrial Classes, who have housed as many as 1200 persons per acre, have shown even a better record than the above; and other companies, where the population per acre is less dense, have much lower death rates.

In London, in addition to the eighteen blocks of dwellings erected by the Peabody Donation Fund, for which an average weekly rent of 2*s.* 2*d.* per room is charged, and six blocks erected by the Guinness' Trust, for which an average weekly rent of 2*s.* 1½*d.* is charged, several large blocks of dwellings have been erected by the London County Council. The East End Dwellings Company, Limited, own eight blocks, the rent charged per dwelling varying from 1*s.* 6*d.* to 5*s.*, and a dividend of 5 per cent. has been paid. The Metropolitan Association for Improving the Dwellings of the Industrial Classes own fourteen blocks, the rent per dwelling varying from 2*s.* 6*d.* to 9*s.* 6*d.*, and a dividend of 4½ per cent. has been paid. The Improved Industrial Dwellings Company, Limited, own forty blocks, the rent per room averages 2*s.* 1¾*d.*, and a dividend of 5 per cent. has been paid. The Artisans', Labourers' and General Dwellings Company, Limited, own ten blocks, the rent per dwelling varying from 2*s.* 6*d.* to 7*s.*, and a dividend of 5 per cent. has been paid. The South London Dwellings Company, Limited, own several blocks, the rent per dwelling varies from 2*s.* 6*d.* to 11*s.*, and a dividend of 4 per cent. has been paid. And numerous other companies, associations and private individuals are engaged in this work.

Many of these companies and associations, however, make no attempt whatever to provide accommodation for the classes by whom it is most urgently required, viz. the casual labourer and the very poor.

The majority of the companies have been extremely successful financially, and there appears to be no doubt whatever that good interest may be obtained for money invested in this class of building; and it is to be hoped that the action of the local authorities will be supplemented by public spirited capitalists, who would thus be able to make profitable investments in such a manner as to benefit their fellow men.

Municipal Lodging Houses.

There is always a very large portion of the population, both stationary and migratory, whose only homes are alternately the workhouses and the common lodging houses throughout the country, and who, from a combination of reasons, make no effort to obtain other homes. This section of the community, notwithstanding the powers given to local authorities by the Public Health Act, 1875, as to the inspection and control of common lodging-houses, still congregate together in dwellings which, in many cases, are most insanitary and utterly unsuited for the purpose for which they are used. Fully recognising this fact, many local authorities have set to work to provide model lodging houses. In Glasgow the Corporation have erected no less than seven lodging houses at a cost of 90,000*l.*, some of which contain 300 or more beds, one of the houses being for single women. The charge per bed varies from 3½*d.* to 4½*d.* per night, and the most successful financial results have been obtained. The beds are mostly on the bunk system, and the space allotted in the best buildings is 400 cubic feet.

A "Family Home" has also recently been opened for the accommodation of husbandless or wifeless parents and their children; 165 bedrooms are provided, for which a rent of 5*s.* per week is charged. The children can be left in charge of resident nurses, and receive breakfast, dinner and supper for a charge of about 3*d.* each per day; a crèche, day dormitory, play-room and play-ground being provided. The cost of the building was about 15,000*l.*

The London County Council have erected a lodging house near Drury Lane. The accommodation provides for 324 persons, 108 cubicles being provided in each of three large dormitories; electric light is laid on; the charge is 6*d.* per night, which sum includes also the use of cooking ranges and utensils, and crockery. A return of 3 per cent. is obained.

The Salford Corporation have erected a lodging house which accommodates about 285 lodgers. The cubicle divisions are of sheet steel, an external fire escape being provided to each dormitory. The space allowed for each lodger is nearly 600 cubic feet, the charge being 4*d.* per bed per night. This house is described as being one of the best model lodging houses in the kingdom. The cost, 14,850*l.*

The Leith Corporation model lodging house provides accommodation for 168 lodgers in six dormitories, each containing 28 enclosed beds. Cooking, dining and reading rooms are also provided.

The Huddersfield Corporation many years ago erected a model lodging house with accommodation for males, females and married couples.

The Darwen Corporation are erecting a house of this class to accommodate 130 lodgers—101 males and 29 females. The methods adopted for separating the sexes, and the general arrangements and accommodation provided are very complete. The cost of the building will be about 6500*l.*

In this connection, one private lodging house may perhaps be mentioned, viz. that erected by Lord Rowton at Vauxhall, London, and which is one of the most completely equipped, and probably the finest lodging house in existence. Accommodation is provided for some 470 men; dining, smoking and reading rooms, barber's shop, lavatories and bath rooms are provided, and a hot or cold bath may be obtained at a cost of one penny, which includes the charge for soap and towel. The dormitories are arranged in cubicles, and the cubic air space for each person varies from 380 to 455 cubic feet. The cost was about 25,000*l.*, and a return of 6 per cent. is obtained.

Other lodging houses have been erected, or are in course of erection, in many other towns, and the work is one which ought to receive further attention, as it is evident that a good return may be obtained on the money so invested.

The charge per bed should be fixed at the lowest possible sum, and accommodation for single women should be provided; and the cubic allowance of space provided might well be increased.

The foregoing brief and very incomplete record of the large amount of most useful work which has been carried out by various municipalities and others, in the endeavour to deal with one of the great social questions of the day, will serve perhaps to show that the poorest of the labouring classes have not yet, to a sufficiently large extent, been provided for, and it is to be hoped that still further legislation may further simplify matters. The question of dealing with unhealthy areas is, to some extent at least, a national one, and it does not seem unreasonable to look for some further assistance, either by way of grant or otherwise, towards the cost of the demolition of unhealthy dwellings.

In view of what has already been done, the outlook however, is

certainly more hopeful as regards the future, and it is to be hoped that county councils and sanitary authorities will not neglect the duties which the law imposes on them, and that in the near future some satisfactory solution of the difficult problem of dealing satisfactorily with the question of the housing of the working classes may be devised.

The Author desires to acknowledge his indebtedness to that valuable contribution to the literature on the subject by Dr. Edward Bowmaker, which forms one of the "Social Questions of To-day Series."

PARTICULARS OF COST OF THE MANOR GROVE WORKMEN'S DWELLINGS, BELONGING TO THE RICHMOND (SURREY) CORPORATION.

	£	s.	d.
Purchase of land, 6 acres 23 perches (only 2 acres 3 roods 14 perches have at present been used)	2,181	0	0
Construction of road and sewers	788	9	4
Cost of buildings, including Clerk of Works ..	12,849	17	6
Preliminary expenses of scheme	240	13	2
	£16,060	0	0

The rents of the dwellings amount to 1037*l.* 8*s.* per annum, and it is estimated that after paying off the loans and interest, and all other charges, and allowing for maintenance and repairs, a balance of 50*l.* per annum will remain.

DISCUSSION.

Mr. MACBRAIR: Before I proceed to the few remarks I wish to make, I should like to call the attention of the meeting to the statement on page 235, that the average death rate has gone down 2·5 per thousand in the dwellings erected in London under the Peabody Donation Fund. It is a very satisfactory thing to us as sanitarians to find the death rate is going down, but I am not quite sure that the preceding part of the paragraph is as satisfactory, for I find Mr. Brierley says the birth rate is 6·4 per thousand higher than for the whole of London. In these days of competition, one is not very anxious that the birth rate should go up, though we are quite satisfied that the death rate should go down. Mr. Brierley says, "A local authority having resolved that a certain area is an unhealthy area, and that an improvement

scheme ought to be made, the question at once arises as to the class of dwelling to be erected in place of those to be demolished." Mr. Brierley almost takes it for granted that workmen's dwellings should be put upon ground which has been cleared as an unhealthy area. That is a rather costly proceeding. If you clear the ground of overcrowded dwellings, you cannot put up as many houses again on the same ground. It seems to me that the best way would be to begin *de novo*. In various large towns flats have been built, but I think, as Englishmen, we are not educated up to living in flats. In Scotland and on the Continent, I believe they are more accustomed to flats than we are. We then come to the question of rents. On reading the paper I could not help thinking that a few mistakes must have been made with regard to rents. Mr. Brierley says the lowest class of cottage is let at 6*s.* and 7*s.* per week rent. I think we might reasonably ask where are the poorest of the workmen of our large towns to find their 6*s.* and 7*s.* a week for rent? A great many of the labouring men in the north only earn 20*s.* per week, some not more than 18*s.*, and out of this they cannot pay 6*s.* or even 5*s.* a week rent. I can understand that a man with an income of 40,000*l.* a year might spend 10,000*l.* a year on rent and manage to live, but when you come down to men earning 18*s.* or 20*s.* a week, they cannot afford to pay 25 per cent. of their income in rent. What we want is a class of dwellings which will suit a man with an income of 20*s.* a week. Then Mr. Brierley says, the houses with a frontage of 12 feet 6 inches have an open space at the rear of $123\frac{2}{3}$ square yards. I should like to ask him whether he means square *feet* instead of yards. If you work that out, with a $12\frac{1}{2}$ feet frontage, it means there is 90 feet open space behind the cottage. If there is really this depth of land, I can understand Mr. Brierley not being able to let the houses for a less rent than 6*s.* or 7*s.* per week when they occupy so much land. Again, the cost of erection is $5\frac{5}{8}d.$ per foot cube. I daresay Mr. Brierley believes in good buildings, and so do I; still, I think $5\frac{5}{8}d.$ per cube foot is a very high price, and if he also gives an excessive quantity of land, the high rent is easily understood. At the present time we have this question before the Lincoln Corporation. At a meeting held about a month ago, I presented a report showing that suitable houses could not be provided for less than 5*s.* a week. For that rent I proposed to give two rooms on the ground floor and three bed-rooms, with the minimum back open area allowed by the model

bye-laws. Several of the members of my committee were quite disappointed. The progressive members of the Council thought that houses could be provided at 4*s.* a week, and when my report showed it could not be done for less than 5*s.*, they began to despair and to talk of giving up the idea. They have asked me to go into the matter again, and see if the price cannot be brought down, because they recognise that the labouring man who only gets 18*s.* or 20*s.* a week cannot afford to pay 5*s.* a week rent. About a mile out of the centre of the city there are houses to be obtained at 4*s.* a week. "If we have to walk a mile from the works at dinner time and back again," they say—to use an Irishism— "we can't do it." Then if the men are working overtime—and I am pleased to say at Lincoln most of the works are—the men do not leave work until seven or eight o'clock at night, and they do not want to walk a long way to their homes. What they ask for is cottages near to the centre of the town at 4*s.* or 4*s.* 6*d.* a week at the most.

Mr. W. Brooke: As the old surveyor to Richmond under the Vestry, I know a little about this scheme. I can understand artisans' dwellings being erected in a town like Brighton, but I cannot understand it in Richmond on the site chosen. I hardly think this Act was intended to be carried out as it has been at Richmond, according to the description given to us in this paper. There are places in Richmond where, if certain slums had been removed and proper artisans' dwellings erected, advantage would have accrued to the Corporation, the town generally, and to the working classes in particular. This is a site which was purchased by the Vestry to get us out of a dilemma as to the refuse disposal and for the erection of a dust destructor. I may say we had originally a Bee Hive destructor, and we kept the destructor going for forty-two weeks, and during that time we had so many protests we had to stop using it. I may say that 8*s.* 6*d.* a week is a reasonable rent for workmen's houses in Richmond. In 1890 one builder alone put up fifty cottages within a stone's throw of my offices, very similar to those erected by the Corporation. Those cottages cost about 135*l.* each. In the middle of Richmond there are vile dens which are still occupied, while the site purchased for a dust destructor is used for erecting these houses. It is on the far side of Richmond between the Gas Works and Railway, about a mile from the centre of the town, and not convenient for artisans' dwellings. These erected by the Corporation are very good houses, they are very substantially built, but I think they are expensive. There is

one builder in Richmond who has put up several of such houses for about 130*l.* each.

Mr. T. DE COURCY MEADE said: I have recently visited most of the buildings that have been described in the paper. The difficulty is to erect suitable buildings that can be let at a reasonable rental. I find that in Glasgow the dwellings arranged in flats are readily taken, and are as a rule successful, but in that city the flat system is general for this class of building. In other towns objections are taken to high buildings arranged in flats. I think one of the first aims of a public authority should be to erect buildings on the areas cleared, of a domestic character, that will as far as possible meet the requirements and come within the reach of the persons displaced. This, however, cannot be done in many cases; I therefore think that flats, as now generally designed, could be modified and improved very considerably by making separate staircases from the street to each set of tenements, and doing away with the continuous balconies and corridors, which are open to objection. By placing verandahs at the rear on the flats above the ground floor, the accommodation of a small yard can often be obtained at a moderate cost. This, I believe, would be much appreciated by the occupiers.'

Mr. MEADE, in reply to Mr. Escott, further said: In Manchester large blocks of model dwellings have been erected by the Corporation to replace buildings removed from insanitary areas. There is, however, another class of cottages about to be erected by the Corporation, to replace houses demolished for public improvements. In this case a site has been sanctioned by the Local Government Board for the erection of cottages at some distance from the areas cleared. The cottages consist of four rooms, and would probably let for a rental of 6*s.* or 7*s.* per week. The ground floor consists of a living room and scullery, with a water-closet in yard, and on the first floor there are two bed-rooms. The drainage of these buildings is kept outside, the sewers being laid in passages at the rear.

Mr. W. BROOKE: I may say an adjoining site was sold about five years ago, and the price was 1000*l.* an acre. That shows the bargain the town of Richmond made in purchasing this land from the Crown.

Mr. ESCOTT: Might I ask what class of cottage the Local Government Board have allowed to be built at Manchester? A tenement cottage, or cottages with two rooms on the ground floor

and three bed-rooms? I am not at all in favour of the Corporation building these houses. I think they ought to be provided by private enterprise.

Mr. A. M. Fowler said: With regard to back to back houses, and these large blocks of artisans' dwellings, I can never bring my mind to the views which are held in this country. I say, in fact, we are almost going from bad to worse. We know in Yorkshire what a back to back house is; but it has often occurred to my mind that in the south of England, and many other places, they do not know what a back to back house is. The back to back house they take their standard from is one of those old miserable dwellings that we call hovels; they have been grouped together in times gone by, have become dilapidated, and they now call them rookeries. If you apply the word rookery in the proper sense, it means these huge blocks five and six stories high. My view is that the working man should be helped in those things in which he cannot help himself. We know very well, as engineers, we cannot succeed unless we have the help of the artisan. Our work is not of the slightest avail unless we can get his assistance. Therefore you must have the working man in your midst to carry out your works. Whatever may be the serious questions that may arise between capital and labour, we must help the working man. Capital comes into this question of workmen's houses, and you make the working man suffer because you cannot give him that area of land to live upon which he ought to have. One way to do that is to subsidise the land for workmen's houses, either by the State or the Municipality. If you will go to Leeds you will see the back to back houses there in blocks of eight with the closet at the end. I remember the death rate in Leeds when it was 40 per 1000 per year. The population was exterminated in 1849—when the residents in Cavalier Street were swept away—by the cholera epidemic. Now Leeds is one of the largest and most rapidly increasing towns in England, and its death rate has been reduced almost to a minimum. That has been brought about, not by building up houses six or seven stories high, but by the vigilant attention of the surveyor, the medical officer of health, and the committees of the Corporation. What I want to bring you to is a model plan of working class dwellings like they have in the town of Leeds. There, nearly every workman is a freeholder, he has his own domain, he has an interest in the soil. The result is that he is not always on strike, wishing to change his habitation and go

from one town to another. If any of you have not read Mr. Broadhurst's little pamphlet on the 'Freehold and Leasehold Statutes of England,' I advise you to read it. It is an echo of his speeches in the House of Commons on this question. In London and in Manchester the whole of the land is eaten up by chief rents, and the working man has not a chance of becoming the owner of his house in those cities. We should all be on the same footing, whether artisans or engineers, and every man should have the opportunity, if he desires to avail himself of it, of becoming the owner of his own house. I am convinced that the present system of building huge blocks of dwellings six or seven stories high, is wrong and will have to be altered. You do not get the correct death rate in these dwellings, because if any one is ill they are taken away to the hospital, and the death is not counted among those occurring in the houses. It is well that we should consider this question most seriously. We do not want men and women crowded together in this fashion. I was in Cardiff in 1868 when the small-pox epidemic was raging there. I remember at that time the surveyor of Cardiff nearly lost his life. As a result of that epidemic the Local Government Board provisions for air space for dwellings were brought into vogue. I lived in a small house in Cardiff at that time. The Local Government Board insisted upon through houses being built, but the rents were so high that working men could not afford to pay them, and were compelled to take in lodgers. When a working man takes in lodgers—perhaps two or three married men and married women living in the same house—it leads to unpleasantness. Then, again, the back premises often get stocked with fowls and all kinds of live stock. Therefore you have not the houses in the same sanitary condition as if one man had the whole property under his own control. The back to back house with proper ventilation is cleanly, and I say it without fear of contradiction, and if I had the time and the figures collated I could prove that these houses are better in Leeds than the modern seven-story rookeries called artisans' dwellings. I may be wrong; I may have most of the officers of health against me; but I am one of those who have opinions and dare to express them. I do not go with the current and conceal my opinions. I believe these huge buildings will be pulled down some day, and that they will have to subsidise the land for workmen's dwellings either by the State or the Municipalities. You may depend upon it we are on the wrong track.

Mr. J. T. Eayrs said: I did not intend making any remarks on this subject. It is a paper I did not wish to discuss, but I think it would not be right for the public to understand that we, as a body of sanitarians, advocate back to back houses. Mr. Fowler is entitled to his own opinions on back to back houses, but those who have considered the question most carefully, I think may be allowed to differ from him. Back to back houses generally would be condemned by nine-tenths of the surveyors of this country, and if I said 99 per cent. I do not think I should be very far wrong. There is no need to compare back to back houses with the seven-story dwellings, which Mr. Fowler has tried to do. There are other classes of houses which can be erected, quite as sanitary, and without resorting to the seven-story dwelling. Most towns of moderate size have sufficient land around to allow them to erect artisans' dwellings without adopting the abominable system of back to back houses, which has been condemned root and branch. I hope it will not go forth from this meeting that we are in favour of, or that we countenance in any way, the back to back house. Without proper ventilation, which is impossible with this class of house, you will not get the death rate reduced to that extent which we all desire to see.

Mr. J. Lobley said: This question is exercising the minds of the authorities in my own town. It seems at present what is wanted is a 6*s.* house at a 3*s.* rental, and these houses are to be provided by the ratepayers generally for the benefit of 100 or 200 persons. I should say the six-story buildings are out of the question altogether in a town like Hanley. They would not be a success financially, neither would they be appreciated by the people. The houses at Richmond seem to be in accordance with the model bye-laws, except that there is a little more land at the back. The model bye-laws require 150 square feet. In addition to that our people seem to think they ought to get a large garden at the back and a small garden at the front of the house, with a bath and water-closet inside, and that they ought not to pay more than 3*s.* or 4*s.* a week rent. We have just built a foreman's lodge at the park, and the Local Government Board refused to pass the plans for that house unless there was a bath and water-closet inside the house. That house could not be let for less than a rent of 10*s.* a week to pay any interest on the capital. I do not think that the Local Government Board would be likely to pass any plans for back to back houses similar to those at Leeds. I have always failed to follow Mr. Fowler's

arguments on this question, even as to space occupied. I do not think that the Leeds system of back to back houses in blocks of eight can save a great deal of land. With regard to lodgers, Mr. Fowler has spoken of the evils of taking several families into a house. I remember, many years ago, when making a survey for street improvements in Liverpool, where four families were living and sleeping in one room, each occupying a corner. The reply to inquiries was, "Oh, we managed very well until so and so took in a lodger." The Local Government inspector said at Hanley, "Why should people be compelled to go outside the house in the middle of the night?" And this would apply with ten times the force to a block of houses with the closets at the end, built on the Leeds plan. We have a large quantity of land round our park at Hanley, and the idea is that this should be utilised for workmen's houses; but the great difficulty is to build the houses so that they will pay interest on the capital. I doubt whether it is the business of the corporation to enter into competition with builders to reduce rents, or to provide houses for a number of working men at very much less than their market value.

Mr. Platt said: In consequence of the remarks of Mr. Fowler, it may be of interest to some of the Members to know that last year Dr. Niven, the Medical Officer of Health for Manchester, read an excellent paper before the Sanitary Institute on back to back and through houses. In order that the matter might be thoroughly investigated, he compared back to back houses with through houses situate in the same area. The records were very carefully kept, and it was demonstrated beyond all doubt that the back to back houses were far the worst, both as to the death rate and the sickness rate. I quite agree with Mr. Eayrs that the comparison should not be made between back to back houses and six and seven-story dwellings, but should be made with the ordinary artisans' houses. It may be of interest, therefore, to know that such a comparison has been made and published in a recent report of the Sanitary Institute.

Mr. Hopkinson: I am now erecting twelve artisans' houses, which are in substitution for houses removed for street improvements. The plans have been passed by the Local Government Board. The houses contain living-room, kitchen, scullery and two bed-rooms. They are to be let at 5*s.* 6*d.* a week, which will pay a very fair interest on the capital.

Mr. G. B. Laffan: It is rather difficult to see what the object

of the municipal authority has been in erecting these cottages at Richmond. Any one passing through Richmond can see these cottages from the railway. They are substantially erected, well arranged, and no doubt well built cottages, in a new street in the neighbourhood of several other properties of a similar class. The difficulty I have is that I cannot understand the object of the authority in erecting these cottages. They must have been erected for one of three purposes, viz. they are either intended to be a model to the ordinary speculative builder, which he is invited to copy; or the local authority intend, by erecting these properties, to enter into competition with such builders, and thereby hope to succeed in making a profit, and thus secure a substantial reduction in the local rates; or they are intended to be a means of providing for housing the working classes of the district. I do not think the local authority can seriously imagine that they are setting forth a model for speculative builders to copy, because we know such builders will put up houses as cheaply as they can, and will not follow the copy of the local authority which has been substantially and expensively constructed. It is outside the objects of a corporation to endeavour to effect a substantial reduction of rates by entering into competition with the owners of property, or in any other way carrying on a business or speculation for profit. Then as to providing largely for the working classes. This no doubt is a proper and legitimate object for a local authority to entertain and carry out, but these cottages are only a few, put up in the midst of a great number of similar properties, and the Corporation are very particular as to whom they let them. The ordinary labouring man—the navvy, for instance—has no chance of getting one of these houses. They can only be obtained by men in regular employment, such as railway men, postmen or policemen. The Corporation only accept a tenant who is in a comparatively good position. What object there can be for a corporation to let property at a loss to persons of this class, seems to be a difficult problem to solve. I cannot see that there is any advantage to a place like Richmond for the local authority to undertake the erection of artisans' dwellings. It is not a *bonâ fide* instance of provision for housing the working classes, but is simply a fad of the local authority.

Mr. Paton said: Several speakers have drawn across our discussion a side issue. The subject of the paper is not whether back to back houses are better than through houses, but to consider

the housing of the working classes as carried out at Richmond. I have followed Mr. Laffan very closely, and he has touched upon a question of the greatest importance. In reading this paper it occurred to me that the Richmond Corporation did not provide these cottages to make provision for a displaced population, but as models, that speculative builders might follow their example. I am engaged in a scheme of considerable magnitude at Plymouth, and the difficulty that presents itself to me is the expense. We are dealing with a condemned area; before that area can be touched we have to purchase land and erect cottages for the displaced population. Those cottages have been erected, and we find we can get barely 3 per cent. That is not a sufficient return to pay the interest on loan and sinking fund, which amounts to 3½ per cent. That means the Corporation will be involved in a charge of ½ per cent. upon the rates. The land was purchased at a fair price (650*l.* per acre), and we find that the result is a charge upon the rates. If that is to be the result of a new estate, laid out under favourable circumstances, what would be the result of purchasing property under the 1890 Act, and compensating owners for the property taken. It is a very serious question for authorities to tackle, and it does occur to me that the machinery placed at the disposal of local authorities is cumbersome and unfair. It must strike one in dealing with this question that local authorities are very shy indeed, and there must be some reason for it. The mode of dealing with insanitary areas, and the method of assessing values, is on the wrong basis. The legislature has been very careful to protect the interest of the owner of the property. Why the owner of a house which is unfit for occupation should be protected more than the man who sells meat unfit for human food I cannot understand. I think there might be an alteration of the law made, so that the medical officer of health could make a presentment to the Grand Jury of the Court of Quarter Sessions of property unfit for occupation. The jury could view the property, and as men of common sense they could tell without expert evidence whether the property was fit for habitation or not. When a case goes before an arbitrator it is possible to bring expert evidence to prove the value of the property to a sum much more than it is worth, having regard to its insanitary state. It occurs to me, if this Association can devote its energy to the improvement of the machinery at the disposal of local authorities it would be doing good work. Looking at the Richmond scheme, some items of cost seem to be very small

indeed. The capital expenditure with regard to the area built upon seems excessively low. I should like to know what has been allowed as deduction on the gross rental in respect of rates and taxes, insurance and other matters of that kind. I cannot bring it down to less than 40 per cent. in Plymouth.

Alderman Sir Joseph Ewart said: It is not right that the public should pay fabulous prices for property which is known to be worthless, and which has been known to be worthless for twenty or thirty years. I believe in a fair system of adjusting the value of property condemned, we should be able to build self-contained cottages for the working classes without loss to the ratepayers, and that would be an enormous benefit to the community. Probably the reason why the opposition is so great at the present moment to the corporation undertaking this duty of building houses, is because the subject is new. You know that every reform meets with opposition, but you also know that where there is a will there is a way. The working classes are utterly helpless; in this matter they cannot help themselves, and it is the duty of corporations to take it up, and not shirk it in the interests of the jerry builders or any one else.

Dr. Newsholme, Medical Officer of Health for Brighton, said: I have, unfortunately, not been able to hear the first part of the discussion, but the subject is one which is of interest to me, as it is to Sir Joseph Ewart, who has just spoken. I believe the subject of back to back houses has been under discussion earlier this morning. I should like to express my opinion that the perpetuation of such a system as that is a scandal to the public health of the country. Leeds is one of the greatest offenders in that respect. I have had an opportunity of seeing a great number of these houses, and I have no doubt that Leeds is building up what will be a pest spot in the future, and the work which is now being done will have to be undone. In Brighton, I am glad to say, we have very few back to back houses, and those we have we are condemning as fast as we can. The total cost of the schemes in the two condemned areas in Brighton has been 64,000*l.*; we have been recouped by the sale of land, 18,000*l.*, making the net cost 46,000*l.* The number of persons displaced by the schemes causes it to work out at 33*l.* per person displaced. Reckoning six persons to a house, it means a cost of 200*l.* per house in dealing with these insanitary areas. That is a large sum with which to tax the ratepayers of the present day. This tax is put upon the community because of

the mistakes made a hundred years ago. There is one point I should like to draw attention to. If any back additions are made to the house and not discovered within six months, the local authority can do nothing to remove those buildings. If that is correct—and our ruling here is that it is correct—then it seems to me that this is a great public loss. Why do we condemn these houses? It is largely because of the lack of air space and dilapidations. If we are going to repeat the lack of air space, if we are going to allow the back yards to be built over in that way, we may have other properties which will have to be condemned, and the people of the future will have to be mulcted as we have been. Your Association would do a splendid work if it could bring about a reform of the law in that respect, and if we could get that remedied we should go far towards doing away with the creation of slums in the future.

Mr. E. J. Silcock: It appears to me that the Author has not gone far enough in his proposals to deal with the housing of the working classes in such a town as Richmond. It appears to be quite within the bounds of economic finance to construct houses somewhat similar to the class A adopted by the Richmond Town Council, but having in addition a large garden—in point of fact, an allotment. In large towns it is obvious that considerations of distance would prevent this idea being carried out on any large scale, but with towns of a population of under, say 50,000, the element of distance is almost negligible. It may be assumed that in towns of this size there are no slums, but experience shows that in the older towns, especially those which were once fortified, or where some geographical peculiarity has retarded the extension of the town, the houses have become very closely built and the air space is very much restricted, and from a sanitary point of view houses can be found quite as bad as those in the larger towns. Some time ago I went into this question and prepared a report and plans for my Corporation, and I came to the conclusion that the proper thing to be done was to build semi-detatched houses containing parlour, kitchen, back kitchen, coal store, pantry, water-closet and three bed-rooms. These houses contained about the same cubic space as the Richmond class A houses, and I estimated that they could be built for 500*l.* a pair, and it was proposed to attach to each house one-twelfth part of an acre of garden. The Lynn Corporation are perhaps exceptionally situated for dealing with such a case, as they have a large quantity of land in the

immediate neighbourhood of the town; but corporations can now raise money so cheaply, and loans for the purchase of land can be spread over such long terms, that I do not think the difficulty of obtaining land would be prohibitive. I estimate that if the money for building these cottages were borrowed at 3 per cent. interest, repayable in thirty years, these houses could be let at 7*s.* per week, and that at the end of the thirty years term the Corporation, although they had up to then made no profit except by the additional rateable value, would have a very remunerative property. It may be objected that houses of this class would be too expensive for the occupiers of the present insanitary houses, and no doubt that is so, but the people who would occupy these houses would leave other houses of the ordinary type, which would thus become occupied by the dwellers in the slums, and the latter would soon become empty. This process would no doubt depreciate the value of slum property at the expense of the public, but the owners of slum property as a rule do not deserve much sympathy at the hands of the public, as their only object in most cases is to secure a very large return for a very small outlay of capital. I therefore think that if corporations could expend capital on building a better class of houses with gardens attached, and so give the working man a real home, they would produce a better sanitary result than if they go in for building terrace houses such as described by Mr. Brierley.

The PRESIDENT, in closing the discussion, said: I should like to say, as you have already heard, this is a subject which has given us a good deal of trouble in Brighton, and my experience is that we want to go to the root of the evil. The first thing that needs amendment is the law by which local authorities can deal with these unhealthy areas. Our great difficulty here, indeed our greatest difficulties have been caused by the great cost of clearing the area before we can start to build, and I have no doubt that may be the experience of others. It seems to me we ought not to be compelled to give a large price, and in some cases a fancy price, for old property which it would be a good thing to burn down. In condemning insanitary areas in Brighton, we have really been putting ratepayers' money into the pockets of the holders of that property. That is one thing that should be altered. Then the whole of the machinery by which we are able to get rid of the tenants, and so on, is so cumbersome, it all tends to make the improvement which is necessary so very much more expensive

than it ought to be. I quite agree with some speakers that the rents charged for the cottages are more than working men can afford to pay; but as Mr. Lobley put it just now, I think it really comes to this, that they want a 6*s.* or 8*s.* house for 3*s.* or 4*s.* a week. That is really what it comes to. We have been trying to build small houses and to let them at 5*s.* 6*d.* or 6*s.* a week, but we were unable to do it; and the land has been sold by the Corporation for private persons to build the houses; but we insist upon the houses being built entirely in accordance with our plans. If you look at the plans in the other room you will see the class of house built in Brighton. The average cost of the house is 225*l.* This house cannot be let for less than 8*s.* 6*d.* a week. That is more than the people can really afford to pay, so we do not get rid of the overcrowding which we wish to do. Mr. Escott has just asked me a question which I ought to answer publicly. The 225*l.* is the cost of the house alone, exclusive of land.

ELECTRIC TRACTION: A REVIEW OF ITS APPLICATION AND A COMPARISON WITH OTHER METHODS.

By R. ST. GEORGE MOORE, M. Inst. C.E.

A civil engineer acting either for a corporation or in general practice, has frequently to advise on matters about which it is an absolute impossibility for him to be conversant with all the details. For instance, in the preparation of a water-works scheme he has to decide upon the type of pumping machinery to be adopted; although it would be unwise for him to attempt to design the machinery, knowing, as we do, that all machinery such as marine engines, pumping engines, &c., has been brought to its present condition by the makers of the various types gradually introducing improvement upon improvement. The same case will apply to traction.

It would, in the first instance, probably devolve upon the civil engineer to decide whether electrical or some other method of traction should be adopted, his knowledge of the nature of the traffic to be carried, the nature of the permanent way, the grades and curves being essential to come to a proper decision. When this decision has been arrived at, then the detail ought to be put into the hands of one of those who have made the method of traction selected their speciality. The Author's object, therefore, in this paper is to consider electric traction, not from an electrical engineer's point of view, but from a civil engineer's, and to describe a few of the leading and most instructive examples, and analyse their merits or demerits. The following lines have been selected for description as illustrating the distinctive features of electric traction.

1. The Brighton Electric Railway.
2. Street railways.
3. The Liverpool Overhead.
4. Brighton and Rottingdean Seashore Electric Tramroad.

The Brighton Electric Railway.

This line is described first, as being the pioneer electric railway in the United Kingdom and Ireland, having been opened by the Mayor of Brighton on the 2nd of August, 1883. (The next being that at the Giant's Causeway in Ireland, which was opened in November of the same year.) Further, because it is one of the best exponents of the application of electric traction on a small scale, with the exception of the permanent way, which is to be renewed shortly.

The line commences opposite the entrance to the Aquarium, and runs for a distance of about a quarter of a mile, principally on wooden tressel work placed on the outside of the sea wall, so that in rough weather the main frame and working portions are open to the salt-water spray, which would be a serious drawback to any other method of traction. The line passes under the Chain Pier and along the top of the beach to the terminus at Paston Place, a total distance of about one mile; the steepest gradient being on the east side of the Chain Pier, which is 1 in 14.

The electricity is supplied from a generating station at Paston Place, the prime mover being a 20 nominal horse-power gas engine.

The power is conveyed from the central station to the cars by a third rail.

The cars weigh complete with motor and gear, but exclusive of passengers, $1\frac{1}{4}$ and $1\frac{3}{4}$ tons; and when fully loaded, $3\frac{1}{4}$ and 4 tons.

With the above plant four cars can be kept running at the same time at (if required) 14 miles per hour, at a total average cost of 4*d.* per car mile. This includes depreciation and repairs, but not interest on capital.

Street Railways or Tramways.

The principal application of electric traction has been its substitution for horse traction on street railways or tramways, as exemplified by those in Dublin, Hamburg, Brussels and Bristol, and a large number of other towns, one company in America having a total length of road of 272 miles and 1705 motor cars.

The initial difficulty of the application of electricity to tramways was the distribution of the motive power.

Two methods have at various times and places been adopted. First, the conductor in a conduit; second, the overhead wire or trolly system.

The first consists of a copper or iron conductor carried on insulators, as in the third rail system, but placed below the surface of the road and protected by an iron casing with a slot in the top, through which slot contact is formed. This system has never been extensively used. The drawbacks to it are its expense, its being liable to get filled with water and mud, and the width of the slot at points and crossings being a great disadvantage to wheel traffic.

The system which has been most universally adopted consists of an overhead conductor, generally a copper wire, suspended on poles similar to telegraph wires, but of course very much heavier, there being about 10,000 miles working with this system in America, and 1000 miles in Europe.

In England considerable objection is raised to this system on account of the danger to the traffic from a falling wire, and the unsightliness of the poles.

The Author considers that the value of these objections has been considerably over-estimated. The danger from the wire has been reduced to a minimum by care and attention, and the poles are now made an ornament rather than an eyesore.

By the kindness of Mr. Philip Dawson, illustrations of the poles used at Dublin and Bristol, together with several specimens of trollies and insulators are shown. The poles illustrated are manufactured in America, English makers not having, until very lately, adopted any good system for making the joints between the varying diameters of the tubing, the adopted test for which is that the pole is to be lifted 6 feet and allowed to fall free, when if any of the joints have telescoped the pole is rejected. An illustration of the pole for the Brighton and Rottingdean Tramroad is also given.

Permanent Way.

If electric traction is adopted in preference to cable or horse traction greater attention must be given to the permanent way, because of the greater weight of a motor car than an ordinary tram-car, or of one for a cable road, and also because of the motor being a delicate instrument to which violent shocks are detrimental. The Americans are using rails as heavy as 100 lbs. per yard, with welded instead of fish-plate joints, but when there is a good foundation the Author is of opinion a lighter section is admissible.

Steep gradients are no detriment to electric traction by motor cars. In the United States they have been made to work up to

1 in 7. If a locomotive is employed the dead weight has to be carried to produce adhesion, whereas with the motor car the car and passengers are the weight producing adhesion.

The Dublin Electric Tramway System.

This system, opened on the 16th of May last, commences near the centre of Dublin and runs to Dalkey—a distance of $7\frac{3}{4}$ miles. The heaviest gradient is 1 in 16. The rails are of the ordinary girder type, weighing 76 lbs. per yard, and the gauge is 5 feet $2\frac{3}{16}$ inches. The trolly system has been adopted; the overhead wire conductor is carried for the greater portion of the distance by means of span wires stretched across the streets; a small portion is carried by the double bracket poles shown. The peculiarity of this installation is that electricity of various pressures is generated at the central station at Balls Bridge. The lower pressure is conveyed direct to the conductor from which the car draws its supply, and the higher to one or other of the two sub-stations, where it is reduced in pressure and supplied to another section of the line. The sub-stations are at Blackrock and Dalkey; the object of this being to save loss by leakage and cost in the conductor; a small conductor being capable of conveying the same power at a high pressure as a larger one can at a low pressure; also to enable them to maintain the pressure required by the Board of Trade in the return current.

The Liverpool Overhead Railway.

This railway runs for a distance of about 7 miles along the inside of the docks at Liverpool; it is carried for nearly the whole of its length on an iron viaduct. There are fifteen stations, averaging about 900 yards apart. Each train consists of two motor carriages seating together 114 passengers, and weighing, including passengers, 38 to 40 tons.

The train service is every 5 minutes, and there are twelve trains either starting, travelling, stopping or at rest, all being actuated from the prime mover situated in the Central Generating Station.

There is one short gradient of 1 in 40, and the sharpest curve is seven chains radius.

Mr. Parker, in his paper read before the Institution of Civil Engineers, gives the cost to be between 3·441 and 4·075 pence per car mile, with about 40,000 car miles per month.

This line and its electrical equipment is very fully described in the papers by Messrs. Greathead, Fox and Parker, volume cxvii. of the Minutes of Proceedings of the Institution of Civil Engineers.

The Brighton and Rottingdean Seashore Electric Tramroad.

This tramroad is one of the latest and most peculiar application of electric traction. Before describing the reasons for adopting electric traction, it will be necessary to give a brief description of the line.

This line is situated on the foreshore entirely between high and low water, and extends from the Paston Place Groyne within the borough of Brighton, to Rottingdean—a distance of 2 miles 7 furlongs. At high water of spring tides, at the deepest portion of the line, the car will run in 15 feet of water. That is to say, the rail-level will be 15 feet below water-level.

The permanent way consists of four lines of 52 lbs. steel flange rails specially rolled with an additional width of flange and thickness of web to compensate for the corrosion which will take place and thereby equalise the life of these portions with the rail-head, the life of which it is anticipated will be considerable owing to the comparatively small amount of traffic to which it will be subjected.

The rails are laid in pairs to a gauge of 2 feet 8½ inches, and to a total gauge between the outer rails of 18 feet.

For the sleepers of ordinary railway practice are substituted concrete blocks and large cast-iron chairs, according to the nature of the ground. Between the rails and the cast-iron chairs and the concrete blocks oak cushions are fixed. Where concrete blocks are used mortises are cut so as to be at least 6 inches into the solid chalk, and a box framed round it of the height required, and the block formed by filling the box with concrete. Although some portion of the line has been completed two winters, after the concrete has once had time to set no damage has been done to the blocks, either by the sea or frost. As may readily be understood a large amount of trouble was caused by rough weather damaging the blocks in their green state.

The precedent for the use of concrete sleepers was the favourable results obtained for slow traffic by the Wurtemburg States Railway prior to the general adoption in Germany of steel or iron sleepers.

The cast-iron chairs are similarly fixed, with the exception that

the mortises are deeper, and where the chair stands more than 2 feet out of the ground, a concrete plinth is built round it.

The rails and oak cushions are fastened to the concrete blocks by two bolts built into the block during construction.

The ruling gradient is 1 in 300, and 40 chain curves (with the exception of one very short piece of curve near the Paston Place Station) have been adopted.

The stations at Paston Place and Rottingdean are small piers or jetties constructed in iron, with a deck, level with the deck of the car, or about 23 feet above rail level.

The car, views of which are given, is carried on 16 33-inch wheels in four bogies, two of which occupy each line of road, and are held in position by a strong steel tube framing. On each bogie stands a main steel tube column, from which spring the arched girders supporting the deck. The level of the deck is 23 feet above rail level, and 46 feet long by 22 feet wide. A deck-house, for shelter in wet weather, 25 feet 3 inches long and 12 feet 6 inches wide, with a promenade deck, is provided. The car, when fully loaded, will weigh about 50 tons, and it would require a wind pressure nearly equal to three times that of a hurricane, or 134·4 lbs. per square foot of exposed surface, to create an equilibrium of forces; that is to say, if the inner line of rail is taken as the fulcrum and the weight of the car as acting vertically through its centre of gravity, we get $9 \times 50 \times 2240$ units of resistance, taking the centre of pressure at 25·0 above rail, the area exposed 300 square feet, and x the lbs. per square foot, we get $x \times 25 \times 300 = 9 \times 50 \times 2240 : x = 134{\cdot}4$. This force would only produce an equilibrium; the force therefore required to lift the car round the inner rail as a turning centre and turn it over, would, of course, be very much larger. The margin of stability of the car from overturning from an impediment in the permanent way is very great.

The electrical generating station is at Rottingdean, and the current is conveyed to the car by an overhead copper wire and trolly pole. The motors are placed on the main deck of the car, and are connected with the driving wheels by shafting down two of the steel tube legs and bevel gearing. On the rear bogies powerful hand-brakes are fixed.

The prime mover is one of Sisson's compound high speed surface condensing engines, indicating 110 horse-power, driving a direct coupled dynamo.

The two motors have an effective brake horse-power of 30 each, and it is anticipated that they will drive the car at six miles per hour.

The selection of a motive power for this line was comparatively easy; there were practically only two to choose between, (1) steam and (2) electricity. Steam, of course, could have been adopted, but the heat from the boiler was looked upon as a disadvantage, therefore electricity was decided upon and adopted.

Mr. Volk and the Author, who are jointly responsible for these works, trust they will have the pleasure of showing such portion of the work as is completed to the members of the Association.

Electricity has established its own distinctive position among tractive powers, viz. for short distance frequent services such as street railways, because, when there are a large number of cars on a system worked from a central station they become like the properly balanced reciprocating parts of a machine.

Take, for instance, a system worked with twenty motor cars, with stopping places every 1000 yards, each car requiring x horse-power for the first 50 yards, some proportion of x for 850 yards, say, for simplicity, $\frac{x}{2}$, and 0 for the remaining 100 yards while stopping, and 0 while at rest. Then, assuming that the traffic could be so arranged that 5 cars were starting, 5 making the centre portion of the run, 5 stopping and 5 at rest, we get $(x \times 5) + \left(\frac{x}{2} \times 5\right) + (0 \times 5) + (0 \times 5) = 7\frac{1}{2}\,x$, instead of the $20\,x$ which would be required if each car had its own engine. Or take it that 5 cars are starting, 10 running and 5 either stopping or at rest, even then we get $10\,x$ instead of $20\,x$. Of course, in this reasoning no account is taken of the greater efficiency of the large prime mover in a central station or the loss in the conduction.

Up to the present it has not been brought within the limits of practical competition with steam for long distance heavy traffic, although considerable experiments have been made in that direction.

The difficulty of selection, therefore, occurs when the traffic to be dealt with is either very light and seldom, or heavy, and for considerable distances, and for these cases no general rules can be laid down, they have each to be treated on their own respective merits. Take as an illustration the very extreme case of a street railway installation for a small town, where the total length of the line would be 2 miles, and where a half-hour service would suffice

for the traffic. Two cars start one from each end at the same time and arrive at their destination 20 minutes after starting, therefore, for 33 per cent. of the time the prime mover is running it is doing no work.

The cable tramway and electrical tramway have one very distinctive feature in common, namely, the central generating station, the difference being the form in which the power is transmitted from the prime mover to the car. The two points, therefore, to be considered are the prime cost of the road and efficiency of the transmitter. The cost of the installation of a cable road is very much greater than that for an electrical trolly line, as may readily be understood when a comparison is made between the cost of the pole and wire and the underground conduit furnished with cable and sheaves, even after allowing for the cost of the dynamos and motors. The efficiency is also less, that is to say, that with a given horse-power at the generating station, the effective horse-power available in the axle would, with the cable system, be just half that with an electrical system. Further, the electrical system is capable of far greater extension without additional generating stations than the cable system, as the length of a cable is limited, and that of an electric system (by the introduction of transformer stations) is, within reason, practically unlimited.

In conclusion, the Author looks forward to the time when the road motor car shall have been brought to perfection, whether it be driven by steam, oil, electricity, or by some power the discovery of which is still in the womb of the future. There is no doubt the advantages to civilisation will be large, but, to a great extent, an unknown quantity. Of one thing we may rest assured, viz. that the increased cleanliness of the streets in large towns will enormously add to their salubrity. What would the general public say if engineers suggested a tractive force which would deposit on the roads the same amount of noxious matter as results from horse traction?

A further advantage will be the decrease in the amount of food stuffs for which we shall be dependent on foreign countries, for instance. The horses in London would alone consume more than the produce of a million acres of ground.

The saving of the space occupied by the horses, which equals at least 50 per cent. of the total area occupied by the traffic, would be sufficient to relieve many heavy congested districts, even in London.

DISCUSSION.

Mr. J. Lobley, in moving a vote of thanks to Mr. Moore, said: Speaking of the comparison between the conduit system and the overhead trolly wire, I can quite corroborate Mr. Moore's opinion that the wires and poles cease to be an objection after a very short acquaintance. I went over to America in 1891, when I was certainly prejudiced against the overhead trolly wire, but I had not been in Boston twenty-four hours before I ceased to notice them at all as an objectionable thing when considered against the overwhelming advantages of the system. Certainly they are not nice looking at the curves, where a great number of cross wires are necessary to hold up the trolly wires. But that has been improved, and the unsightliness is being gradually removed. With regard to the conduit system, I dare say a good many of the Members have seen the conduit system at Blackpool, where it has been in operation for many years. I have been frequently on that line, but I think only on one occasion have I been able to get to the end of the line, owing to the conduit being choked up with sand. In the winter the mud and snow would act in the same way. The Author alludes to the danger to the traffic from falling wires with the overhead system. He does not say anything of the different methods of overcoming that danger; there is no doubt it is an appreciable danger. Two years ago a good many of the Members saw it at Brussels, and I have since seen it at Havre. In the latter place, where a telephone or telegraph wire passes over the trolly wire, the latter is for a short distance an insulated wire. Of course the car has to depend upon the momentum acquired to carry over that insulated part of the wire, but they do not find in practice any difficulty about that. The other point I should like to ask Mr. Moore about is the gradient. He says that a gradient of 1 in 7 is no difficulty with this system in the United States. That is an important point. I have ventured to say I have gone up and down a gradient of 1 in 8 in the city of Lynn in Massachusetts, but I did not verify the levels of that line and am unable to vouch for it. The engineer showing me round told me it was 1 in 8, and it was certainly very steep. I must, however, remind the Members that they have a different way of designating gradients in America to what we have in this country. They

describe them by percentages, and whereas I understood the engineer to say 1 in 8, it might really be 8 per cent., which would actually be 1 in 12½. So you see it is easy to get astray on this point. We usually consider that iron will slide on iron at 1 in 10, so that this gradient would be impossible unless you could overcome this tendency, by the wheels gripping the rails or by mountain climbers. The other day this Association had a little experience at Hanley of what I believe is the steepest gradient in England worked by a steam tramway—that is a gradient of 1 in 13½. I asked the manager to put on the best car, which was one of light wheels having two bogies, and was not a good clincher. Perhaps it was the weight of some of the Members, anyway some of us had to get off the car before it could surmount the hill. There is a great difference between 1 in 13½ and 1 in 7. I think that is subject to verification.

Mr. J. T. Eayrs seconded the vote of thanks, and said: By the title of the paper one would imagine that other than electric traction methods would be described more fully, and the cost of construction and working of other systems given. Very little or no mention is made of cable traction, which is a very popular form and one which is not going into obscurity in favour of overhead electric traction. I am not going to advocate the claims of cable traction this morning. I think the electric overhead system has a very great future before it, and the more we see of it the more popular it will become. A few more particulars as to the cost of construction of the different systems would have been of very great interest to the Members, and would have enabled them to have formed some idea as to the different systems. Of course every road must be taken on its merits; a system which is suited to one town would be unsuited to another. Therefore it takes a great deal of discrimination to select the system which would be the most efficient and economical. The conduit system is being pushed forward, but up to the present we have had no paper read at our meetings respecting that system. There is no regular line at present in operation in this country, except a short trial line. There is one paragraph on p. 254 I should like to remark upon, and that is that the poles are made in America. I was astonished and surprised to find that statement. I think it is a great reflection upon English manufacturers, who cannot supply the poles which are to be used in this country. I may say there is an English manufacturer who is already commencing the manufacture of these

poles on the American system. There is no difficulty in the construction of the poles, and it is surprising that there has not been sufficient enterprise hitherto to manufacture them. The drop test which is used in America in connection with the manufacture of these poles is a very simple one, and causes no difficulty whatever.

Mr. A. E. Collins: I wish to ask Mr. Moore whether he can express any opinion respecting the capabilities of the Westinghouse system referred to by Mr. Eayrs, by which the electric current is transmitted through buttons sunk in the street surface. Mr. Moore tells us that transformers are used on the Dublin system. Can he tell us of any alternating current transformer motor suitable for traction?

Mr. T. H. Yabbicom said: As reference has been made to the electrical tramway at Bristol, I may just refer to what has been done there, because the line has been open and successfully worked for several months. There was a considerable amount of opposition on the part of the Council to the adoption of the overhead system, and a deputation took the precaution of going to other places and seeing the system at work, before they allowed it to be adopted in Bristol. The results of these visits was that they gave consent for the system to be tried on one length of the tramways. That has been working so satisfactorily that the Council has given permission to the company to extend it to another length. The statement that poles can be made so as to be ornamental rather than an eyesore must be taken *cum grano salis;* but against any ugliness on the part of the poles, must be considered the convenience to the public and the smoothness with which the cars are run. The system in Bristol has its terminus in a street varying from 80 feet to 120 feet wide, where the pole with the double bracket placed in the centre of the street is used, and an arc lamp is placed on the top, the whole occupying no more space than the arc lamp formerly did. In narrow streets the pole with the single bracket is used, placed on the edge of the foot-walk, the arm being of variable length according to the distance of the track from the edge of the curb. Therefore it is impossible to say they do not, to a certain extent, incommode the public; but the advantage of the system has been so great that the public have asked, and almost demanded, an extension in other directions, and in consequence the Council has given permission for it to be laid down in another district. Formerly, for a short time steam traction was tried on another

route in the city of Bristol and given up. It was found that the engines frightened horses to such an extent that the consent was withdrawn. Up to the present time, with the electric system, there have been very few accidents from horses taking fright. Outside the limits of the city the electric system runs through the district of St. George, and no doubt Mr. Lewis will give you his opinion of it.

Mr. T. L. Lewis: I should like to support the statement of Mr. Yabbicom as to the success of the electric trolly system in Bristol. I may say this, that Mr. Yabbicom has all the plums of the system, for he has got the widest street and the narrowest street. Three-fourths of the line is in my district, running on variable gradients, one of 1 in 16, and I can promise Mr. Lobley when he comes, that there shall be no getting down from the cars and walking up hill. The public have taken up the tramway with very great spirit, and an extension of a mile and a half is about to be made in my district and the city of Bristol. With regard to the wires overhead, we had some experience of those at Wallsall, but our poles are much more substantial and also more ornamental, and I do not think any one will object to them after about a month. This paper and the Author's remarks are timely and most interesting; the description of the Brighton and Rottingdean Tramway is, I think, the first complete description that has been made of this novel application of electric motive power. Great courage is due on the part of both engineer and the financial party interested with him to carry out such an undertaking. I hope that they will find in it the same success which has attended the work heretofore done in Brighton by Mr. Magnus Volk, who was one of the first pioneers in electric motive power. It seems to me that no problem is of a more pressing interest to us municipal and county engineers, than how to best avail ourselves of modern motive power. From every point of view it is absolutely essential to extend to the uttermost possible limit the available residential area surrounding our cities and towns, and that can only be done by decreasing the time of transit, and increasing the ease with which the workers can be transported to their suburban homes. From a point of hygiene only, such advantages cannot be overestimated. It is almost unnecessary for me to rehearse the wonderful progress that electric traction has made during the past seven years. I find there are 36,000 electric tram cars running in the United States and Canada. On the continent of Europe

there are now some 3000 in operation, and our colonies have already about 1000 cars at work. Bristol and Dublin have conclusively demonstrated that electric traction can satisfactorily fulfil the demands of an English corporation, and in both of these cities large extensions are about to be made, and very considerable additions to the rolling stock as well. To us the question involved must largely be submitted, and it is incumbent upon us to take careful note and observations of the advantages which our various corporations will unquestionably obtain, by offering to their populations the greatest possible facilities for intramural and suburban extensions of communication.

Mr. E. J. Silcock: The Author of the paper says, in his opinion it is necessary that the permanent way must be very much better for electric than for the cable or other form of traction. I venture to think that in practice this will not be found to be the case. The ordinary girder rail laid on a concrete foundation is little enough for anything, and good enough for electric traction. On page 257 Mr. Moore says "it would require a wind pressure nearly equal to three times that of a hurricane, or 134·4 lbs. per square foot of exposed surface, to create an equilibrium of forces;" but it appears that 50 is substituted for 60 in the second calculation. Then, on the last page, the Author says that "the effective horse-power available on the axle would, with the cable system, be just half that with the electrical system." I should like to know how Mr. Moore arrives at that calculation. It appears to me that every case must be taken on its merits. You cannot say that the power available with the cable will be half or any other proportion, as it varies as in other systems. As to whether cable or any other system will be preferable for any particular case, you must take into consideration the traffic. If you have only sufficient traffic for a 5 or 10-minutes' service the electric system is the cheapest. It requires something like a $1\frac{1}{2}$-minute service each way to enable the cable to compete for price at all. The actual figure in a case I had to do with was $1\frac{5}{8}$-minute service, and then the electric and the cable came out at the same cost; and with a more frequent service the cable was the most economical. The cable has certain advantages over electric traction outside the question of cost; there are in the first place no poles or wires, which are considered very objectionable; then there is no sparking, which does occur with electric traction during certain conditions of the atmosphere; then you do not get any

grinding action on the rails, and hence the permanent way lasts longer; there is no humming or buzzing from the motors, and there is no danger from falling wires. Then, again, when you have a large traffic to deal with you can put on extra cars with a very trifling further expense. On the other hand, with the overhead electric system there is no central slot, and there are two rails instead of three, which is a distinct advantage over the cable system; the proportion of the total power actually used is greater than with a cable system, and the cars can be run at different speeds, according to the district they are running through. When the cars get outside the towns, where there is not much traffic, they can put on the pace and thus make up for loss of time, and by varying the speed the ordinary road traffic can be avoided with an electric car; but the cable tramcar can never exceed a fixed maximum speed, viz. the speed of the cable. Then cable trams interfere with street construction, which is not the case with the overhead electric, and a broken cable stops the whole of the traffic on the system, whereas a broken electric wire only stops a very short section of a few yards in length. These points to my mind are very strongly in favour of the overhead electric, and the probability is we shall see it very largely developed in England in the future. Really the greatest hindrance at the present moment is the alleged unsightliness of the poles and overhead wires, but I venture to think that anything which is good enough from an æsthetic point of view for the boulevards of Brussels, is good enough for the manufacturing towns of England.

Mr. E. G. Mawbey: At Leicester we have put up some poles in lieu of street grids as ventilations for the sewers. They are steel tubes of 6 inches and 9 inches in diameter. It is astonishing, considering the diameter, the immense amount of air that passes through them. I think these poles for carrying the overhead wires might very well be used for sewer ventilating shafts. In Leicester we had one complaint, and only one, for it happened that the tube was not connected with the sewer at the time.

Mr. J. Patten Barber said: I should like a little further information from Mr. Moore with reference to the calculation as to the stability of the car, which is given on p. 257. I do not know whether the centre of pressure, which is referred to as 25 feet above rail level, is taken from the perspective drawings which I see before me. If so, the platform or deck is 23 feet above the rail level, and with a shelter or deck-house on the plat-

form, 10 or 12 feet high, it seems to me that the centre of pressure should be more than 25 feet. If so it would materially alter the calculations. Then as to the weight of the car when loaded—50 tons—I should like to ask whether that is the weight loaded, and with the four bogies and a portion of the steel framing submerged. We are told that 15 feet will be submerged at times; that will take off a considerable portion of the weight. The wash of the waves, together with the force of a hurricane, might produce oscillation, and when once oscillation has been started you require to allow for a very large margin of safety in order to prevent a catastrophe. Probably Mr. Moore would let us know further about the figures on which he has calculated the moment of stability of the car.

The PRESIDENT: Before putting the motion I wish to add my personal thanks to Mr. Moore for the trouble he took to prepare this paper. Mr. Moore and I have been associated together very agreeably for some time at the various works he is carrying out here, and although not a Member of our Association, I called upon him, asking him to prepare this paper, which I thought would be of very great interest to the Members generally, seeing that it is a subject which a great many towns throughout the country are now considering; and seeing that Mr. Moore would be able to point to works that he had done, I thought such a paper would not be unacceptable to the meeting. From the great interest which has been taken in the paper, I feel highly gratified, and I am sure that Mr. Moore will feel that he has not worked for us in vain. It has indeed been a very interesting paper.

Mr. R. ST. GEORGE MOORE, in replying to the discussion, said: I feel highly gratified by the kind way in which you have adopted this vote of thanks, and I should like also to express my thanks to your President for having given me the privilege of writing this short paper. I trust those Members who have heard it to-day will look at it leniently, because I think nobody in the room knows so well its defects and shortcomings as the Author. Mr. Lobley called attention to my remark as to the gradient of 1 in 7. I believe my authority for making that statement is reliable, but I beg also to state that I do not recommend that electric tramroads should be laid on gradients of 1 in 7. I should be sorry to be forced into carrying out one at such a steep grade. Mr. Lobley also objected to the title of the Brighton and Rottingdean Tramway. When the Bill was deposited in Parliament it was called a

railway, as it undoubtedly is. But we were met with this difficulty. If a railway then it must be fenced, according to the railway department of the Board of Trade. On the other hand, the harbour department of the Board of Trade said, under any circumstances you must not fence it in; the consequence was we had to amend the title and substitute the word tramway. I think Mr. Lobley also said he took an interest in titles. He may be interested to know the title or name which has been given to the tramcar—it is called "The Daddy Longlegs." Mr. Silcock asked a question as to the weight of the small cars. I mention it as an example of electric traction applied on a small scale, and Mr. Volk, who is present, is my authority as to the weight of the car. The two first cars were small, but the two cars which he put on the road last year are heavier. Mr. Barber referred to the calculations. The calculations, which were taken purely and simply as an example for the paper, are for the cars standing and in the dry.

Mr. J. Lemon: I do not think Mr. Moore answered the question with reference to the permanent way, as to running an electric tramway on the road now used for horse traction.

Mr. Moore: If the rails were laid down as used to be done years ago for horse tramroads they would not be strong enough, but a great many tramroads of the present day undoubtedly are strong enough with the girder rails.

STREET CONSTRUCTION FOR MEDIUM TRAFFIC.

By ARTHUR E. COLLINS, Assoc. M. Inst. C.E.,
City Engineer, Norwich.

This paper has been prepared by the Author with the object of causing a discussion on the very important subject to which it relates.

In the great majority of provincial towns the provision of such high-class and, of necessity, expensive pavements as those required and constructed in Liverpool, parts of London, and other large towns, would cause unnecessary and extravagant expenditure; on the other hand, gravel, flint, or macadam, are not found to be adapted to the requirements of many streets in such provincial towns, and the engineer has to adopt methods of construction which, whilst not so expensive in first cost as the high-class pavements, shall have most of their advantages, and shall avoid the mud, dust, and heavy charges for cleansing, watering and maintenance always accompanying the use of gravel, flints, or ordinary macadam in the streets of towns.

The three intermediate classes of carriageway paving, of which the author has had more or less experience, are the following:—

(1) Sett paving, with and without concrete foundations.

(2) Wood paving, with and without concrete foundations.

(3) Tarred macadam, on pre-existing macadamised road foundations.

It is, probably, universally admitted that a syenitic granite sett pavement forms the most durable street surface known: when its joints are made in such a manner as to remain watertight, it is a good paving from the sanitary point of view. It is, however, so noisy that, in the opinion of the Author, it should never be laid in streets having good residential property, offices, or shops abutting upon it. For streets through manufacturing districts and in similar situations, it is difficult to find sufficient reasons against its use to outweigh its undoubted advantages. The Author has laid such pavements with both cement and pitch-grouted joints, and is

of opinion that, with equal care, one method is as good as the other as regards stability and imperviousness; each method has its own advantages and disadvantages.

Cement grouting can be done at any time, excepting during frosty weather, but the pavement must not be subjected to traffic for at least a week after it is grouted.

Pitch grouting cannot be done to be sure of good results in cold or wet weather. The pavement may be opened for traffic immediately it is completed, and it is not so noisy as where cement grouting is used. The success or failure of pitch grouting depends on the efficiency of the person in charge of the pitch boiler. If the mixture be too hard, it pulverises in very cold weather; if it be too soft, it runs and becomes sticky in very hot weather. When it is intended to use pitch grouting, the joints of the pavement must be filled with clean, dry shingle or stone chippings, and after thorough ramming and regulating, the joints must be again so filled; the pavement is then ready for grouting, which is best done with a lipped iron can. The pitch should be poured into the joints, leaving as little on the tops of setts as possible.

For the average class of traffic found in provincial towns, and where granite paving is substituted for a macadam surface over a well consolidated bed, an impervious granite sett paving will last for many years before depressions make it necessary to relay it; if, however, water is permitted to penetrate the surface, the paving soon becomes uneven. To avoid this, a thin layer of cement concrete has been found efficacious, the principal office of which, in the author's opinion, has been to increase the imperviousness of the construction, thus preventing churning and local yielding of wet material below the setts.

The Author sometimes lays down such thin layers of concrete in the following manner: a layer—say three inches thick—of gravel having been laid, watered and rolled, it is thoroughly sluiced with water, so as to wash down all loamy matter, and cement grout is swept into the interstices. The granite paving is laid upon this in the usual manner, after an inch layer of sand has been spread on the concrete. Time is allowed for the cement to set before any ramming or other operation likely to disturb it is commenced.

When granite paving is used in a town where macadam is prevalent, there are, the Author thinks, more accidents to horses in proportion to traffic than where granite is more general; this is due to the facts that horses in the former case are not so well

accustomed to the sort of foothold; further, horses in such towns are not usually shod in a suitable manner to enable them to travel with safety on granite paving.

From the point of view of first cost and maintenance, wood paving is more costly than granite; from the sanitary point of view it is also inferior to granite (if nervous diseases are not taken into account); it is, however, the quietest pavement, suitable for medium to heavy traffic, of which there is much experience; it gives fairly good foothold to horses, especially in the case of uncreosoted deal. The extension of wood paving is almost invariably asked for by the public wherever it is laid.

Excepting in Norwich, the Author is unaware of wood pavements having been extensively laid, excepting on concrete foundations; in Norwich about sixteen miles of streets have been paved with wood during the past twenty years, the greater part of which pavements have no such foundations.

When the Author first entered upon his duties in that city he was convinced that the construction of wood paving without concrete foundations must end in failure; his experience during the past two years has proved to him that, at any rate in Norwich, the presence or absence of such foundation appears to have little, if any, effect on the wear and life of the pavement, provided that where concrete is not used the pre-existing road bed is thoroughly sound.

One of the Author's predecessors, Mr. Marshall, a former member of our Association, in a report to the Norwich Council, dated February, 1888, says:—

". . . I have satisfied myself as to the manner of laying down the wood pavement—that is, in regard to the foundation—whether a greater wear of the pavement is occasioned, more or less, by the absence of concrete. Upon a careful examination of the streets, and taking up a course of blocks without disturbing the sand beneath them, I find that the wearing away of the blocks into holes is not occasioned by any settlement in the foundation; in every case I have found the formation undisturbed."

The Author has made many similar investigations with, in most cases, similar results to those recorded by Mr. Marshall.

The traffic in Norwich, whilst not including many heavy individual loads, is close and continuous, the streets generally being narrow and winding, the traffic is more concentrated and trying to the street surfaces than the same volume and weight would cause in most towns. Unfortunately, the Author has had no opportunity to cause records of the traffic to be made. Uncreosoted deal

blocks were generally used for the first twelve years after wood paving was introduced here; they were bedded on sand. After about the seventh year from laying such pavements, they became rough; they had to be renewed during the eighth or ninth year. About ten years since, pitch pine and creosoted deal blocks began to be used; the pitch pine was not successful, the heart wood wearing better than the surrounding rings, notwithstanding great cost incurred at the time of laying in removing sap-wood. Creosoted deal paving, laid in 1888 without concrete foundations, but bedded on sand and grouted with cement, is still in use, and in good order, excepting as regards slight roughness where it is on a gradient of one in thirty, and is subject to the climbing and backing actions of horses' feet.

No difficulty has arisen in the use of cement grouting for the joints of creosoted deal blocks. Where such paving is opened for sewer &c. trenches it is usually found necessary to chip the cement from the blocks. Pitch grouting has been used with creosoted deal with great success as regards imperviousness, but the creosote from the blocks has so altered the temper of the pitch as to cause trouble during very hot weather. All wood paving is now laid with close joints, the courses being forced together with the aid of sledge-hammers at about each twelfth course.

As far as can be ascertained, no pavements in Norwich are laid on roads passing over clay, in every case the soil is either gravel or chalk. This is a most important feature in the case.

In January last the Author made an endeavour to elicit the opinions of borough engineers and others on the subject of tarred macadam, but the replies received to the questions sent out vary so much that it is difficult to make any general statement founded upon them; from his own experience, however, he is of opinion that where the gradients are suitable, and the traffic such as that usually found in suburban streets, tarred macadam forms an enconomical pavement which is much appreciated by residents.

Wherever tar is used, skilled and attentive workmen must be employed to obtain satisfactory results; when such works fail, it is usually found to arise from either—

(1) The use of an excessive quantity of tar.
(2) The use of watery or insufficiently boiled tar.
(3) The use of pitch to thicken unsuitable tar.
(4) The use of flinty or other non-absorbent gravel or stone.
(5) Insufficient consolidation.

It is probable that the constant, careful supervision necessary to

commence with to obtain good results with tarred work, has prevented its general adoption. The Author has had very varied experience with his work in this connection, some unsatisfactory, some satisfactory.

A properly constructed tarred macadam roadway is easily cleansed, quiet, easily repaired where opened for connections, &c., economical in maintenance, and, being impervious and offering no lodgement for dirt, it is a good pavement from the sanitary point of view.

The material used for tarred macadam, or tarred pavements generally, should be hard, close-grained iron slag, or hard, blue mountain limestone, or hard Kentish rag.

The tar should be boiled until thick; when allowed to cool, it should be capable of being drawn out into thread-like filaments.

Good results are not likely to be obtained by thickening tar with pitch.

The stone should be heated to such an extent only as to drive off all moisture, and, whilst warm, the boiling tar applied. Each particle of stone should be completely covered as thinly as possible with tar. Where the bottom is thoroughly good, a coating of tarred macadam three inches thick is sufficient for the class of traffic for which such pavement has been described as suited. The material for the first coat to consolidate to three inches thick should be broken to $1\frac{1}{2}$-inch gauge, and after thorough consolidation with a steam roller it should be faced with tarred $\frac{1}{2}$-inch material, to fill up and seal the surface and be re-rolled. The top should be dusted with dust of the stone used and ground lime in equal quantities, and a hand-roller passed over to press the dust in and prevent it from blowing about.

The Author has seen tarred macadam which, after twelve years' use, required very little repairs. He has constructed tarred macadam crossings in macadamised and gravel streets, which have outlived two renewals of the surrounding surfaces.

In preparing existing macadam for repairs, or for taking it up to make way for paving, a suitable macadam scarifier is of the greatest assistance where power is available to drive it. If the works of a town are of sufficient magnitude to make it worth while having a scarifier, it enables several of the men usually employed in lifting macadam, to be employed in other work, leaving the scarifier to lift the macadam more expeditiously and effectually than is possible at reasonable cost by manual labour.

The paper on the subject of macadam scarifiers which the Author had the honour of reading before this Association in 1894, states his views on this subject. The Author will not amplify them now, excepting to say that his further experience increases his conviction of the utility of these machines. The city of Norwich possesses a most efficient scarifier, made by Messrs. Manlove & Alliott, of Nottingham; it is pulled and pushed by a 15-ton compound engine steam-roller, of Messrs. Aveling & Porter's construction.

COST PER SUPERFICIAL YARD FOR CONSTRUCTING AND MAINTAINING STREET CARRIAGEWAYS IN NORWICH.

Description of Road.	First Cost.	Perpetual Maintenance which includes Renewals.	Cleansing.	Total Annual Cost, excluding Capital Charges.
	s. d.	*s. d.*	*s. d.*	*s. d.*
Syenitic granite macadam, including gravel foundation	4 6	0 9	0 10	1 7
Uncreosoted deal paving, 5 in. deep, on sand bedding and jointed with sand	5 6	1 1	0 5	1 6
Pitch pine, 5 in. deep, laid as last	7 0	1 3	0 5	1 8
Creosoted deal, 5 in. deep, on sand bed grouted with cement .. .. Note.—None of this pavement has required renewal up to the present. It is assumed that with slight repairs it will last four years longer, making 12 years in all.	8 0	0 10	0 4	1 2
3 in. by 5 in. syenitic granite paving, on sand bed, joints grouted with pitch. This supposes pavement will have a life of 25 years, it allows for taking up and repaving twice during that period, and for small repairs ..	8 0	0 $3\frac{3}{4}$	0 3	0 $6\frac{3}{4}$
Tarred macadam, including gravel foundation .. Tarred macadam, 4*s.*; foundation, 2*s.* Note.—Very little of this material has required repairs during the time it has been in the Author's charge. He has assumed that once in 5 years it will require refacing, that with this attention it will have a life of 20 years in the class of streets where it is suitable.	6 0	0 6	0 3	0 9

NOTE.—In the last three cases the costs of maintenance are partly estimates.

Ordinary macadam forms one of the most expensive street surfaces known to the Author, as regards maintenance and cleansing. Accounts which have been kept in Norwich show that syenitic granite macadam in the city streets costs 6*d.* to 1*s.* per superficial yard per annum for maintenance, and from 8*d.* to 1*s.* a yard for cleansing; taking the average at 9*d.* and 10*d.* respectively, the total average amounts to 1*s.* 7*d.* per yard.

DISCUSSION.

Mr. E. G. Mawbey: I may say a word as to our experience in Leicester. We are in the granite country, and we lay our granite paving on a bed of six inches of concrete. We have come to the conclusion that this is the best pavement for those parts of Leicester where noise is not of very great importance, and where the traffic is very heavy. We have laid a quantity of hard wood, that is, the Australian wood, and I have had an experience there with which I dare say a great many of you are acquainted. We tried the jarrah wood in one street, with several methods of grouting and laying. One sample was laid with the blocks close together and grouted with cement; another close and grouted with pitch and tar; another sample, with the blocks a quarter of an inch apart, grouted with cement; another a quarter of an inch apart, grouted with pitch and tar. The worst of the whole lot was the one laid a quarter of an inch apart and grouted with cement; and the best was that laid close together and grouted with pitch and tar. I should not be surprised if, after several years, the piece laid with the open joint is all ribbed and rounded like the old beech wood paving used to go.

Mr. S. S. Platt: I should like to ask Mr. Collins to further explain the table at the end of his paper, giving the cost of construction and maintenance of the roadways in Norwich. Is the cost given intended to meet the cost of repayment of loan, or is it simply the cost of taking it up from time to time. The cost of maintenance is very much less in Manchester than in Norwich, if it does not include repayment.

Mr. Yabbicom: I should like to ask what the subsoil is on which Mr. Collins lays pine blocks without any bed of concrete, because it seems to me that the condition of the soil below exercises a very great influence upon the wear and tear of the

wood paving. I have never laid any wood paving without a bed of six inches of concrete. If it could be successfully done it would very much reduce the expense. It is, however, a question to me, whether the high cost of maintainance, which is put down at 1*s.* 1*d.* and 1*s.* 3*d.* per yard per annum, is not caused to a very great extent by the inferior foundation. Some four years ago a scheme was brought out for laying a roadway with oak pegs. I believe it was tried only in Bristol, but an attempt was made to introduce it into several other towns, and from a number of questions I have received about it, the promoters are still endeavouring to get installations of it laid down. Round oak pegs varying in diameter from two inches to five inches were used, and the principle was to lay these pegs, which were five inches in length, on a bed of sand only; the idea being that concrete would not be required, reducing the cost, and thus offering a temptation to people to adopt this method of paving. Leave was given to lay down a street in Bristol with these oak pegs, but at the end of the second year the whole of them had to be removed and the ordinary pine block paving laid. That is the only experience I have had of laying paving without concrete. The reason it had to be removed was not that the oak pegs had worn, but owing to the surface having become wavy, water lay on it and percolated through to the foundation, utterly destroying it. The expense of maintenance of pine wood paving in Bristol does not come to anything like 1*s.* 1*d.* or 1*s.* 3*d.* per annum. I have recently laid down 150,000 yards, and speaking roughly, the annual cost of maintenance does not come to more than 7*d.* I feel inclined to think that part of the high rate of maintenance mentioned has been caused by an indifferent foundation.

Mr. J. Lemon: I am very much of the same opinion as Mr. Yabbicom. I had a curious experience of wood paving. Some twenty-five years ago I published a report on wood paving in its earliest stages. I went up to London and other towns. I was much struck by the wood paving which was laid on wood planks. I do not remember the name of the company which laid it.

Mr. Barber: The Improved Wood Company.

Mr. Lemon: I came back and was much disgusted with what I saw. In my report I remember saying, "My opinion of wood paving is that the first consideration is the foundation, the second is the foundation, and the third is the foundation. I have seen no reason to alter my opinion on that point. I believe every-

thing depends on the foundation for wood paving. When I heard to-day it is proposed to lay it without any foundation, I certainly was astonished. I hope it has succeeded, but I believe the high rate of maintenance has something to do with it. I should like to ask a question as to tar macadam; I have had no experience of it. I should think, although you may lay down a successful road with tar macadam, the difficulty of its repair comes in. If it gets out of repair I don't see how you are going to repair it unless you take it all up and relay it again. I think there must be some great difficulty about that.

Mr. Cooper: There is one point upon which I should like to speak. Mr. Collins says, "it is probably universally admitted that syenitic granite setts form the most durable street surface known." I think there is one point which should be borne in mind when considering a street paving, and that is the effect upon horses and rolling stock. It is a point which is left out of most of the papers which are read on the various forms of street pavements. But everybody knows that granite setts are most noisy, and injurious to both horses and rolling stock, the life of which is much reduced by travelling over such setts.

Mr. S. Stead: I should like to say one word with regard to tar macadam. In Harrogate we have laid a great quantity of tar macadam. We find it makes a very good road indeed; it is much appreciated, but it is only suitable for light traffic. When made with limestone (the material we use at present) it is not suitable for heavy traffic, and I do not think could be made to answer for that class of traffic. It is easy to repair, much easier than ordinary macadam, because you can chip out the portion to be repaired, and fill in with the tar macadam, join it up quite easily, and roll it with a hand roller and make a very good job of it.

Mr. J. Patten Barber: I remember some years ago, when wood paving was first laid in the city of Norwich, and I think most of the surveyors in London were surprised to find that it was proposed to lay wood paving without a concrete foundation. That has been a matter of surprise to me ever since. I understand that the blocks are laid on a subsoil which is a mixture of chalk and gravel, so I suppose we may take it that the wood paving, although not upon concrete, is upon a sort of rough natural concrete. Then I think we must accept what Mr. Collins says, that the wear of the wood paving is in no way the result of its being laid without a concrete foundation. When we have a state-

ment that an examination has been made and no depression has been found in the foundation, we ought to accept it without question. Mr. Marshall examined the paving, took up some blocks, and he found there was no depression in the foundation corresponding with the depression on the surface. Mr. Collins has made a similar investigation, and in all cases the results of Mr. Marshall's finding is borne out. For my part I accept that. I do not think we ought to dispute the observations made by Mr. Collins and Mr. Marshall, and I receive them in all confidence. I wish to ask Mr. Collins something about the table which he has given as to the cost of maintenance of various kinds of pavement; I am still a little puzzled about it. The second item in the table, uncreosoted deal paving 5*s.* 6*d.*—lower down we find the life will be twelve years, while the cost of maintenance is put at 1*s.* 1*d.* Is that really the cost of maintenance per annum, exclusive of the first cost, as stated in the last column of the table? If so, it appears that it would be cheaper to take up the whole of the paving some years before it was worn out and to put down new blocks, than to expend a sum of 1*s.* 1*d.* per yard super. per annum in maintaining it. I might mention an instance of granite paving with cement grouting, on a road with a tramway and heavy traffic along it. During the three months that work was going on I could not close the whole width of the road, and the traffic over the portion remaining open caused such an amount of vibration that I was all the time afraid of the work. However it has stood, and stood very well.

Mr. Lemon: I do not doubt for a moment the statement made by Mr. Collins as to the condition of this wood paving; but I say it proves nothing, as it is laid on a kind of natural concrete.

Mr. W. Weaver said: The first point I wish to touch upon in this paper is the statement on page 270 with regard to the absence of concrete foundations. I do not think it very much matters whether your foundation is composed of concrete or something equal to or better than concrete. If you have got something practically as good as concrete, it would be waste of money to take it up and put concrete in its place. I found that out some years ago when I was wood-paving roads, and found the foundation consisted of good macadam several feet in thickness. The wood paving in the Kensington Road is laid on the old macadam floated over with fine concrete, and this foundation has stood since 1880, and the wood blocks thereon renewed in

1890. The first piece of paving I recollect being laid without a concrete foundation was in the Kentish Town Road. The wood was laid on a sand foundation, but that pavement was an utter failure. Whether its non-success was owing to the foundation, or the way in which the blocks were laid with half-inch joints, I cannot say. In Kensington I have over 200,000 yards of wood paving down, and this area has been renewed either once or twice, making over half a million yards of wood paving laid under my supervision. The result of my observation is this, that where you have a macadam road costing not less than 1*s.* per square yard to maintain, it is cheaper, as a matter of economy, to turn that into a wood-paved road with blocks 5 inches deep. The blocks I lay are 5-inch creosoted deal. In a report to my Board a few weeks back, I ventured to suggest that it would be better to wood-pave a road even where it cost only 10*d.* a yard per annum, leaving a margin of 2*d.* for the improvement to the locality. I believe if you wood-pave existing macadam roads in a district, it lifts up the property and enhances the value of it to the extent of the differential 2*d.* which I allowed in my report. With some of the figures given in the table I do not agree, and I think it would perhaps be misleading if those particulars were taken as a foundation to guide engineers as to the laying down of wood paving. In the first column uncreosoted deal is put at 5*s.* 6*d.*, and creosoted deal at 8*s.* That makes a difference of 2*s.* 6*d.* for creosoting. The difference it makes to me is 1*s.* per yard; that is wood creosoted under pressure, whereby 10 lbs. of creosote are absorbed into a cubic foot of wood. It has been pointed out to me that that difference of 2*s.* 6*d.* is not accounted for altogether by the creosoting, but that there is a difference in the method of grouting. The cost of creosoting with me is, as I said, 1*s.* per square yard. As to maintenance, I have kept very exact accounts of the cost of repairs of all my own main roads. In the first three years there is virtually nothing spent; it is a little the fourth year; and then increases each year until you get to the end of the life of the wood. It amounts in my district to an average of 3*d.* per square yard per annum during the life of the wood.

Mr. Lemon: How many years?

Mr. Weaver: Eight or nine years. With regard to cleansing, I cannot give figures for that. It is a very difficult matter, as far as I am concerned, to separate the cost of cleansing one road from another, as a cart when picking up refuse in one road finds it

convenient to take refuse from adjoining roads. Speaking generally, the cost of keeping wood-paved roads clean is a great deal more than the cost of labour upon a macadam road, but the quantity of stuff removed from the roads bears no comparison with a macadam road. That is to say, you have to spend more for your broom men, but the result in material collected bears no proportion in bulk to the quantity you would take off a macadam road. Therefore it may be taken that although the labour costs more, the money saved in getting rid of your refuse balances the other, and the total cost is really less on the wood road than the macadam road. With regard to the relative durability of hard wood and ordinary deal, that is a matter I do not intend to touch upon. I have got 3000 yards of hard wood laid, and it is receiving careful observation, but there is not sufficient evidence as to its life to warrant me in putting it down in preference to the creosoted deal. Creosoted deal blocks last on my main roads eight or nine years. I have just let a contract for some 8000 yards, the blocks to be laid with cement and asphalt grouting on a 6-inch concrete foundation, at 9*s.* 6*d.* per square yard.

Mr. W. A. Davies: I should like to ask Mr. Collins as to the amount of traffic on the roads in Norwich.

The President, in closing the discussion, said: Brighton is peculiar in not having paved roads of any description. The whole of the 70 miles of roads in Brighton are macadam roads, and there is a great objection on the part of the inhabitants to the introduction of any other kind of roadway, although here, as elsewhere, they are continually grumbling at the condition of the roads in dirty weather. I have advised my Corporation on many occasions to substitute paved carriageways for macadam carriageways in the busiest parts of the town, on those roads on which the traffic is exceptionally heavy or continuous, Brighton being a pleasure town, the front—i.e. the King's Road and the Marine Parade, being the principal drive for carriages—I think it would be very improper for me to advise any other road there than a flint macadam road. A flint macadam road, in my opinion, properly made and cleansed and kept in repair, is the most pleasant road possible to drive over. That is an opinion which prevails here very strongly. On the other business roads, the Western Road, North Street and James Street, and other roads which are subjected to a heavy omnibus traffic, I have granite macadam, but even then I find that the cost of maintenance of

these roads, owing to the traffic, exceptionally heavy. When I tell you there are many roads in Brighton which cost 2*s.* 6*d.* a yard for maintenance only, I think you will agree with me I am right in advising the adoption of a paved road for a macadam road. I think the average cost of maintenance of our principal roads, the roads having the heavy traffic, is 1*s.* 7½*d.* per super. yard. I have tried my very utmost to persuade the Corporation that the continuance of this kind of macadam road is altogether wrong, and I have been pegging away at them for a long time. A few months ago I submitted a further report, and begged of them to let me lay down some small pieces of pavement, say 500 yards length in different streets, that they might see the difference. After considerable discussion they said I might put down 50 yards of different pavements in succession in a flat part of the town, the bottom of North Street, and I was not to exceed 250 yards in length. The result is so unsatisfactory I have declined to try the experiment. It would be a useless waste of time and money, and the results would be misleading; therefore I absolutely declined to entertain the proposal, and I am still going on with macadam. One great difficulty we have here is the gradient of streets: our steepest gradients are 1 in 8 or 1 in 9. The top part of North Street is 1 in 20, and we have several of the principal streets equally steep. I should be sorry to lay wood paving on roads as steep as those. In the streets running from east to west (the natural fall of the ground being from north to south) we get a gradient of 18 inches on the cross section, and the roads being also very narrow, it is difficult to know what kind of pavement to introduce there. Another difficulty is that our main streets are very narrow. In these narrow streets we have the main sewer in the centre, gas and water mains on either side, telephone and telegraph wires and electric cables, all laid in the roadway, because a peculiarity of old Brighton is that under the pavements almost every other house has a cellar, and we could not lay our electric cables, &c., under the footway; therefore everything has to go under the roadway. Many of these roadways being so narrow, I am afraid to introduce a permanent pavement, because it would be so frequently disturbed to get at gas and water mains, &c., and after being down two or three years the surface would be so cut up that it would be full of indents. With reference to the foundation, the town is built wholly on the chalk, and a chalk foundation is good enough for any ordinary road; but we find that in the

winter if there is not a good thick coat of metal on the chalk, when we have a frost and the frost breaks, the chalk swells and bursts up the surface of the road, and the traffic churns it up. Many of these roads are then more like mortar heaps in a bui'der's yard than a public highway. We are mending our ways in this respect. Our new roads which are likely to be subjected to heavy traffic we now form with a proper foundation, so as to get an efficient substance on the top of the chalk to prevent the frost from affecting it.

Mr. A. E. Collins, in reply to the discussion, said: I am very much obliged to you for the vote of thanks you have been so kind as to pass. Respecting the remarks as to the paving in Leicester, I think where you are not using creosoted wood, pitch can be used with more certainty for the joints than where the converse is the case. The difficulty I have had to contend with in using pitch has been the over-creosoting of the wood. In fact there has at times been sufficient creosote in the blocks to turn the pitch into tar again. The tables at the end of the paper, as to the cost of maintenance, are in accordance, as far as I can obtain the particulars, with the books of the Norwich corporation. It is not simply the annual repairs included under maintenance, but the reinstatement when the wood or other paving is worn out.

Mr. Weaver: It is maintenance and renewal.

Mr. Collins: I have seen the piece of paving laid in Bristol which has been referred to by Mr. Yabbicom. It had been laid probably eighteen months when I saw it, and it had worn very rough. That was due, I think, partly to the fact that the weight of a wheel or other load coming on to one of the comparatively small diameter pegs is transferred through the peg to a small area of supporting foundation, and partly to the small amount of surface friction or binding existing between a series of round pegs, compared to that between tightly fitting squared paving blocks. No one could be more prejudiced against laying wood paving without having a good concrete foundation than I was when I went to Norwich, but I could not get over the fact that some of the paving laid without concrete was as good as that on concrete. Some of the old paving was laid with wide joints and uncreosoted wood of a cheap class, and in a very few years the wood got very rough. We have some uncreosoted wood paving which has been laid twelve or fifteen years, and it is in a frightful state. Where we have laid creosoted deal we have not found it wear rough. The

cost of maintenance in Norwich is said to be excessively high, but the streets are narrow and the traffic is constant and concentrated. I have described the traffic in the paper as "close and continuous, the streets generally being narrow and winding." I am not able to give it you in tons per inch because I have not had it taken; if I had been able to give this the paper would have been more valuable. I do not say that in no case have I found the sand bed indented, but in very few cases has it been indented. In cases where paving has got into a very bad state, and the water has soaked through, there I have found impressions; but in no case where the paving has been in good condition have I found an impression. There is one advantage in laying the blocks on a sand bed: when the surface gets rough from wear the blocks may be reversed, and you can get a smooth surface again. There is no doubt as to the truth of what Mr. Cooper says, as to the injurious effect of granite setts on horses. Mr. Stead has practically answered Mr. Lemon's question as to tar macadam, and I can confirm what Mr. Stead says. You will notice I do not recommend it for heavy traffic, but as a suitable pavement for suburban roads. It is a pavement which is not worn out so much by the elements as ordinary macadam; the advantage is that, being an impervious pavement, the water does not get into it. I have known cases where tar macadam has been laid in a narrow street with heavy traffic, and it has worn very well. I have always been surprised at this, and should not have laid it myself in such a street. I think my answer to Mr. Yabbicom as to the comparative cost of repairing pavement in Norwich may answer Mr. Weaver's question. With regard to the apparent discrepancy between the costs of creosoted and uncreosoted wood paving, those in the tabulated statement are actual costs. I may say we do not lay any uncreosoted deal now. The last time it was laid in Norwich was about eight years since, and the cost of that is the cost that stands in the books against it; the 8*s*. I give is the actual cost at the present time for creosoted paving. With regard to the cost of cleansing, great care was taken to get the exact figures. Certain areas were carefully mapped out, and the gangers who work over those areas had to give in the particulars of the work they had done there when they came in at night. Every one knows the difficulty of getting such costs accurately, but I believe the figures given are very near the actual costs. I agree with the President that the most pleasant road to drive over is a flint or gravel road; I also agree with him

that it would be quite misleading to take a test of 250 yards lineal of wood paving as a guide; I think the dirt which would be carried on to it from the macadam would vitiate the test.

Mr. J. Lemon: I say advisedly that nearly all the returns we get of the cost of roads are utterly fallacious; everything depends upon the width. All future statistics should be based on *the same width* of road. I say that 8 yards is a fair average width for the carriage road. I thought at the first blush the cost of maintenance in the paper was very excessive, but when Mr. Collins explains that the roads are so very narrow, the cost is easily understood.

STEAM ROLLING.

By E. PURNELL HOOLEY, Assoc. M. Inst. C.E.,
County Surveyor of Notts.

With the anticipated alterations in the laws relating to steam and other horseless carriages on our highways, the present seems a time when any experience on steam rolling will be useful, if not welcomed by surveyors in charge of highways, as well as the public in general, and in the hope that the experience gained by one who has used steam rollers on all sorts of roads at all periods of the year, on many kinds of material, will be interesting, the Author gives the following information.

No published history of the first experiments in the manufacture of steam rollers is, as far as the Author knows, available for reference, but the following may be taken roughly as the earlier career of steam rollers. Many claims have been laid as to the *first* idea of steam rolling, and the Author has been many times informed by a man now deceased, that *he* first gave the idea for a roller to a noted firm who had hitherto only made traction engines. He used to tell his story somewhat thus: "Many years ago I was laying the water pipes in ——. We could not satisfy the surveyor as to reinstating his roads. One of these ugly great traction engines kept going past our work, so I said to the driver one day, 'Just run your hind wheel up my trench.' It was a very wet day and down went the trench; I filled it up and had the wheel on again, and so I kept on. When the surveyor saw my trench, he said he had never seen a better job, and set about showing how the whole road could so be made, if a portion could be made with a comparatively narrow wheel, and thus you see I started the idea of steam rollers."

Whether this really had anything to do with the original rollers the Author does not profess to state, but this man verily believed what he said, and may really have given the first thought for the matter.

In 1865, a roller was designed by Messrs. Gellerat & Co. of Paris. (See Plate I.) The roller wheels were carried by the bed-

plate under the boiler. The crank shaft was connected to the two axles by two endless chains, both front and hind rollers being driven.

The steering was effected by diminishing or increasing the distance between the ends of the axles by means of two blocks running on a right and left-hand threaded spindle. When the axles were parallel, the machine of necessity travelled in a straight line.

The disadvantages of this roller were—(1) the smallness of the roller wheels caused the road material to be driven before them; (2) the steering was slow and ineffective; (3) the wide rigid rollers destroyed the contour of the road; (4) the fuel consumption was considerably over 2 tons per 10 hours' working; (5) the road was left ridged instead of smooth.

In 1865, Messrs. Morland & Co., feeling the cruelty and unsatisfactory method of allowing the ordinary traffic to consolidate the freshly laid road material, constructed a covered-in steam roller (see Plate II.) that weighed about 40 tons. The idea of covering was naturally to hide the steam horror, but the result may be guessed, and the Author has never heard but that the attempt was a failure.

Whilst these spasmodic attempts were being tried, the originators of the present firm of Aveling and Porter were working to perfect their ideas.

In 1865, a trial was made in Hyde Park by this firm in steam rolling. An ordinary traction engine had its wheels exchanged for heavy and wide roller wheels. The trial was considered a success, and the next improvement was the roller (see Plate III.) supplied by this firm in 1867 to Liverpool; this may be interesting to explain in detail, as it marks the first and best change over previous attempts.

The engine was an adaptation of the ordinary road locomotive, and was carried on four roller wheels of equal width, the two front acting as drivers, and the hind ones, being fixed on a turntable, formed the steering wheels and overlapped the space between the two driving wheels.

A single cylinder was placed on the forward part of the boiler, and was surrounded by a jacket in direct communication with it; the steam was taken into the cylinder from the dome on the top of the jacket. Priming in steep ascents was prevented, the use of steam pipes either inside or outside the boiler was thus avoided, and an important saving of fuel effected. From the crank shaft the motion was taken by spur gearing to a counter shaft, carrying

at the end the pitch chain wheel. The bearings of this shaft were placed in curved slots formed in the supporting brackets, so that the shaft could be raised, and the endless driving chain connecting it to the driving axle tightened it when necessary ; a wrought-iron casing surrounded this driving chain, securing it from dirt or dust. The crank shaft carried a fly-wheel: thus it was anticipated it would be practicable to employ the engine for driving stone-breakers or other fixed machinery when not required for rolling. The pitch chain and brake wheels were keyed fast to the driving axle on which the roller worked free, so that when turning sharp curves either wheel could be thrown out of gear by withdrawing a wrought-iron bolt connecting it to the pitch chain or brake wheel. The turntable was arranged to admit of the driving and steering wheels accommodating themselves to the curved surface of the road, it being hoped that the weight being equally divided between the front and hind wheels, the compression would be uniform. A powerful friction brake, acting upon one of the driving rollers, and worked by a screw from the foot plate, gave complete and rapid control over the machine. The roller was steered also from the foot plate by a chain attached to the turntable, and worked by worm gearing. A tank to contain water and increase the weight was placed over the hind steerage wheel. The cost of this roller in Liverpool was about 1000*l.*, and the daily working expenses amounted to about 20*s.* per day.

About this period, Mr. Paget, Chief Engineer to the Metropolitan Board of Works, published a pamphlet on the 'Economy of Road Manufacture,' which is generally supposed to have greatly popularised the use of the steam road roller. In this pamphlet he states that the French estimated the saving in steam rolling (although the French rolling was no more advanced than ours), merely through the longer duration of the road, at 50 per cent., as compared with horse rolling, and in support of this it may be stated that the Islington and other vestries made trials with a similar result.

In 1871, the Edinburgh Road Trust purchased one of the first road rollers of this type (see Plate IV.), and from a report in the 'Scotsman' of March 14th of that year, it seems to have given great satisfaction.

In 1872, a roller appeared known as the "Lemoines" steam roller (see Plate V.), again a French experiment very much on the lines of the "Gellerat." The boiler, of the "Kesterton" type,

is carried in a similar manner, the double cylinder engines being placed under the boiler. The steerage was similar, excepting that the power of driving the gear was obtained from the engines carried on the foot plate.

The driving rollers followed the steering rollers, power being communicated to the driving axle by a spur wheel and pinion. The gear, &c., however, was much too complicated, and the disadvantages too many to enter into competition with a more simple type of roller.

In 1873, Andrew Lindelof, of New York, patented a steam road roller (see Plate VI.), and claimed for it to be the first successful road roller patented in America. The boiler, which was of the pot type, carried double-acting vertical engines, the crank shaft being connected to the driving rollers by a bevel wheel running in a spur ring on the end of the driving roller. The steerage gear consisted of a hand wheel and screw, working in a block pinned on the end of the tiller, fixed to the vertical shaft of the steerage roller fork. Play was allowed for by a joint between the fork and the vertical shaft at its lower end.

This roller was shown against the roller sent from England to the Philadelphia Exhibition, and as an English road-maker, the Author is proud to say the English roller took the prize.

Other rollers (see Plate VII.) seem to have been attempted by John Whittingham, C.E., of Nantwich, and Robert Douglas, but the writer has been unable to ascertain that either of these rollers had a very long life or showed any improvement on those made by other makers, but they serve to prove that the public were becoming alive to the necessity of steam road rolling.

In 1873, at the Vienna Universal Exhibition, Aveling and Porter, finding their work was appreciated, but to what extent the Author knows not, brought out a new patent steam road roller of smaller type (see Plate VIII.) than the one that was supplied to Liverpool, which, without superseding it, presented some points of improvement and adaptability. The object of the invention seems to have been to obtain a cheaper and more universal roller than the type of roller previously described. While the general arrangement of the ordinary road locomotive was adhered to, the driving wheels were widened to form the side rollers, the space between them was covered, and the fore part of the boiler carried by a pair of steering rollers. This type of roller was more easily adapted to driving a stone-breaker and for doing the work of

an ordinary fixed engine. Other advantages it possessed over the older type of rollers were—(1) steeper inclines could be ascended; (2) one man had the whole control of the engine instead of two; (3) more easily adapted to traction engine purposes. This type of engine was most certainly a step in the right direction. Its great drawback, however, was in the fore carriage: the front rollers being tapered, naturally had a tendency to run apart to the right and left of the engine. The wheels were kept in line by the front axle, which had thus a tremendous amount of strain and friction to withstand. The weight of this engine was 8 tons, the power being 5 horse nominal. The conical front rollers gave rise to a certain amount of slip between the road surface and the roller wheel, and by means of this slip the designers intended to obtain a ramming, or downward, as well as the ordinary pressure produced by a roller on the road.

From this period, year by year, fresh models of varying importance have been introduced, of more or less value, but chiefly more interesting to the mechanical than the civil engineer. Thus the position of the driving gear was several times changed. Rollers were sent out with awnings fitted over the drivers. These may be an absolute necessity in countries with hot climates, but for English use a good suit of reliable oilskins is of far more value and utility.

In Paris the authorities use or compel their contractors to use a 25-ton roller; but for English ideas this is far too heavy, and unlikely to execute any exceptionally good work.

Another idea for rolling has been that illustrated by Plate IX., being an ordinary roller fitted with a tank under the fore part of the boiler, and is intended to do away with the necessity of water carts for watering purposes. The Author has never seen any of these rollers at work, nor has he met with any road-maker who has tried one; the idea may be good, but he is afraid the combination will never be extensively used in England.

Whilst all these various types of rollers have gradually been perfected, little seems to have been found out towards improving the wearing powers of the wheels; when this is discovered the greatest trial will be over. Many ideas have been tried, and the renewable rims were to do all we wanted; but, alas! good as they may be, they might be better. From the Author's experience, for a casting of the weight of ordinary roller wheels to be machined and turned to receive the T-ends of spokes,

PLATE I.

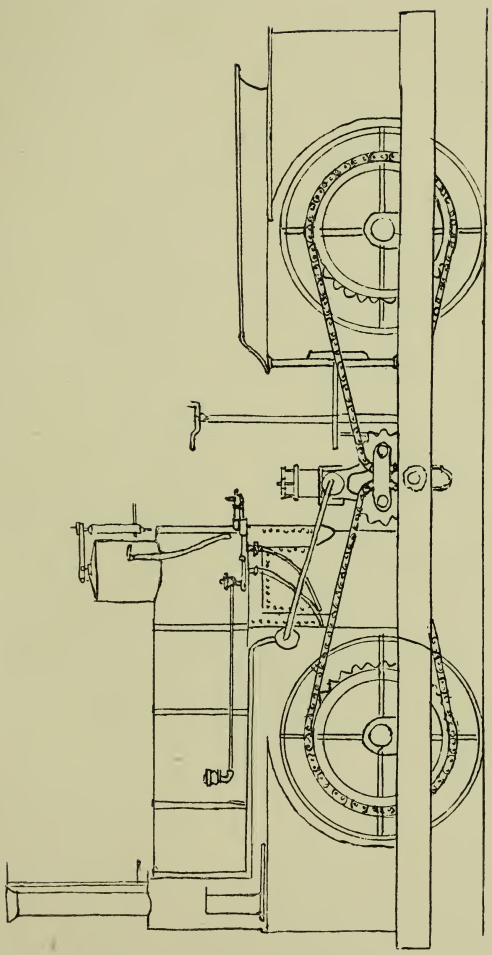


PLATE II.

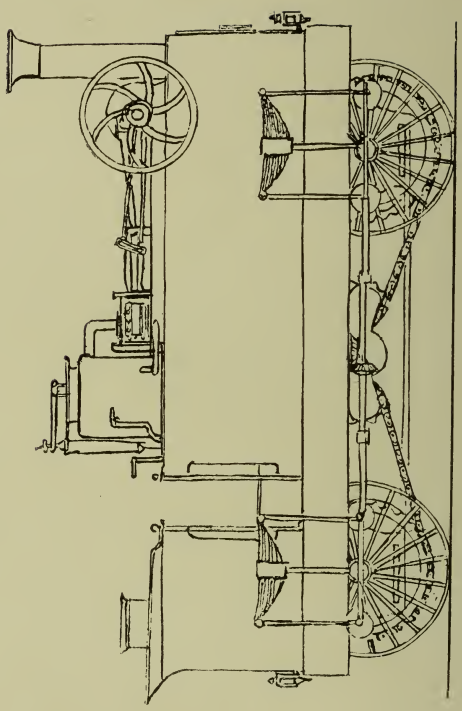


PLATE III.

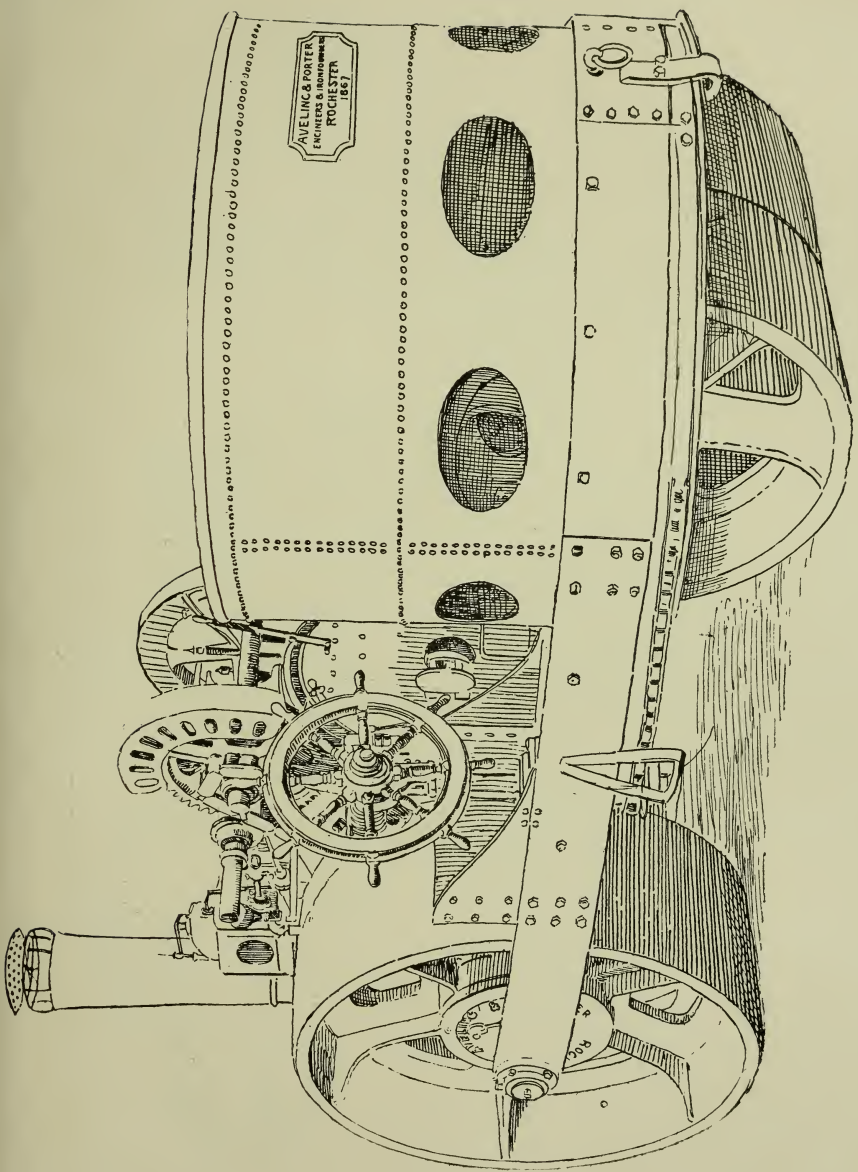


PLATE IV.

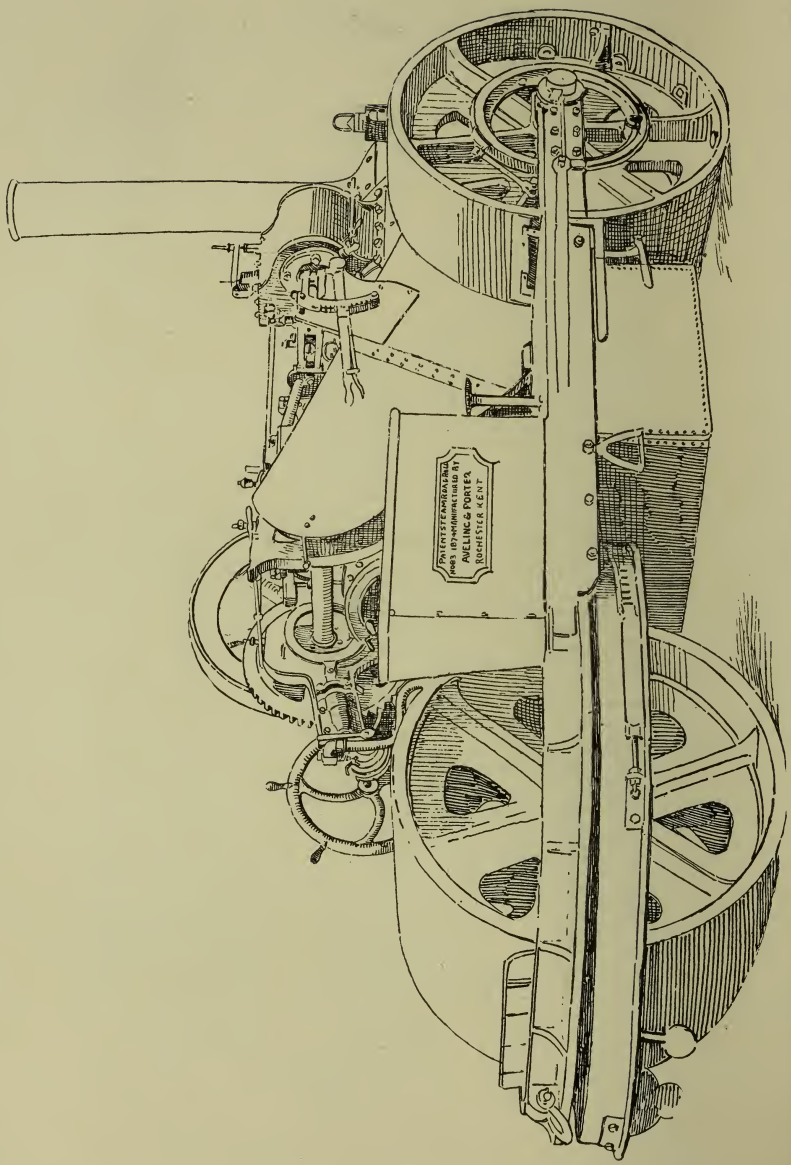


PLATE V.

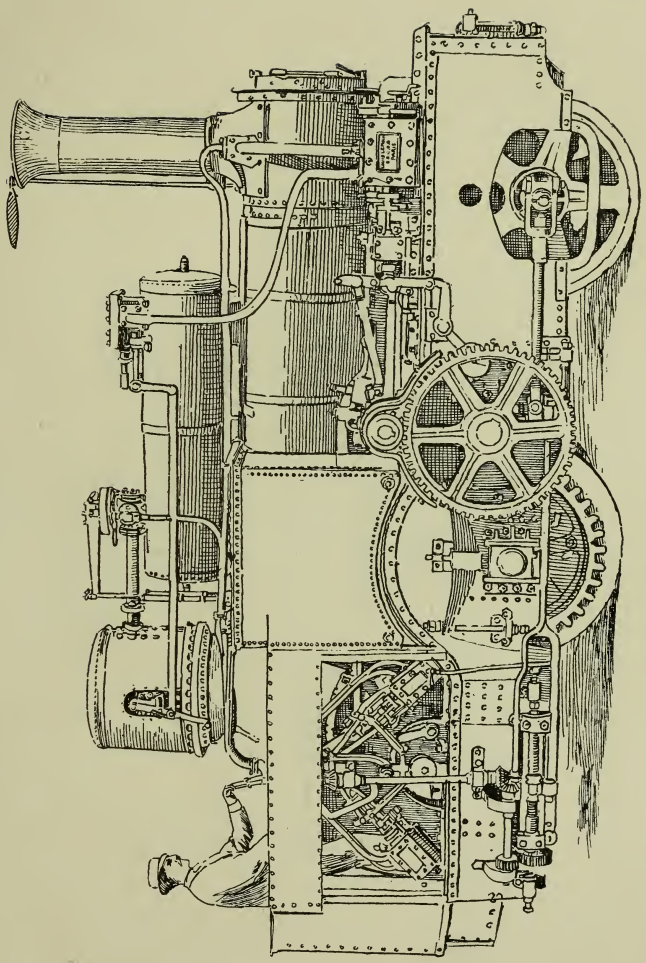


PLATE VI.

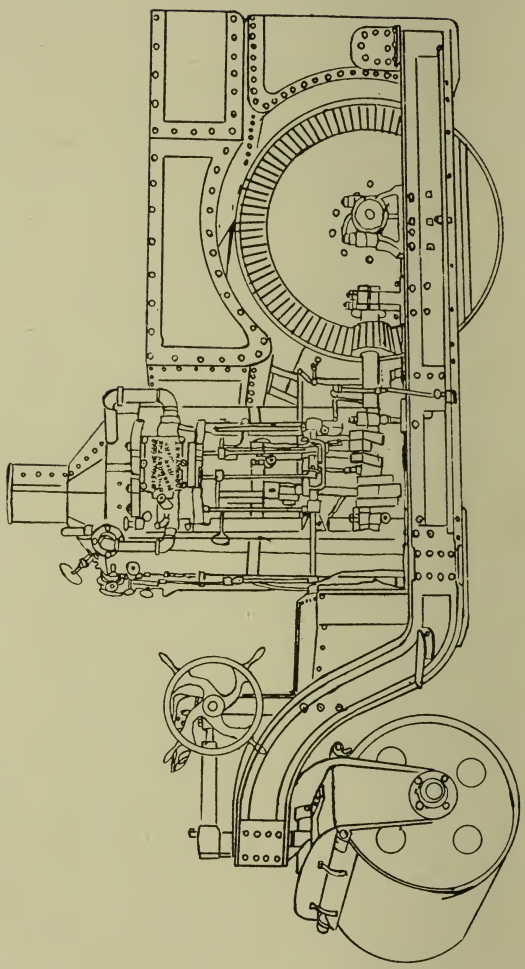


PLATE VII.

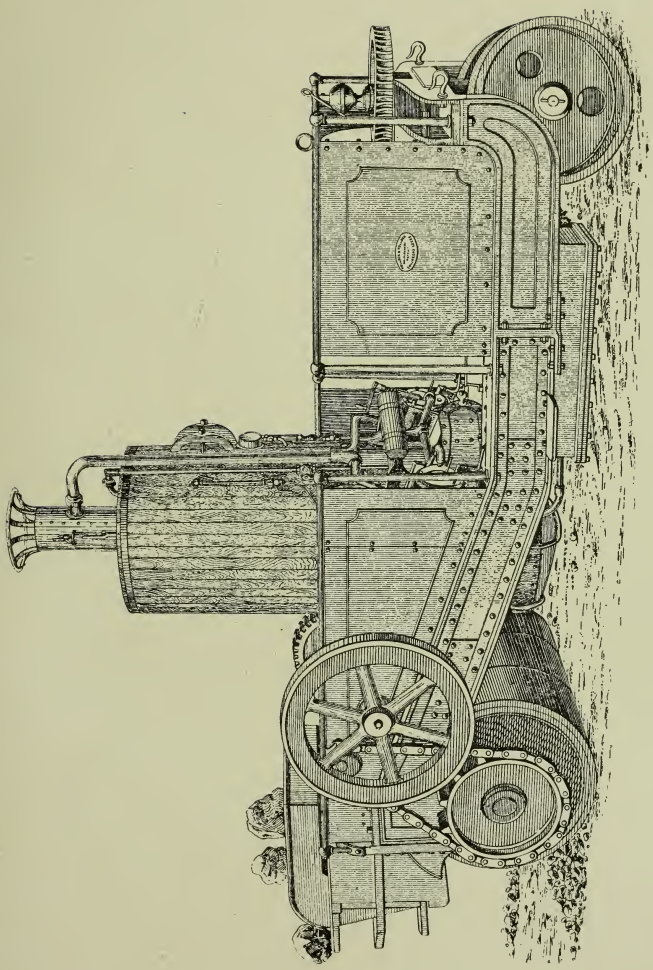


PLATE VIII.

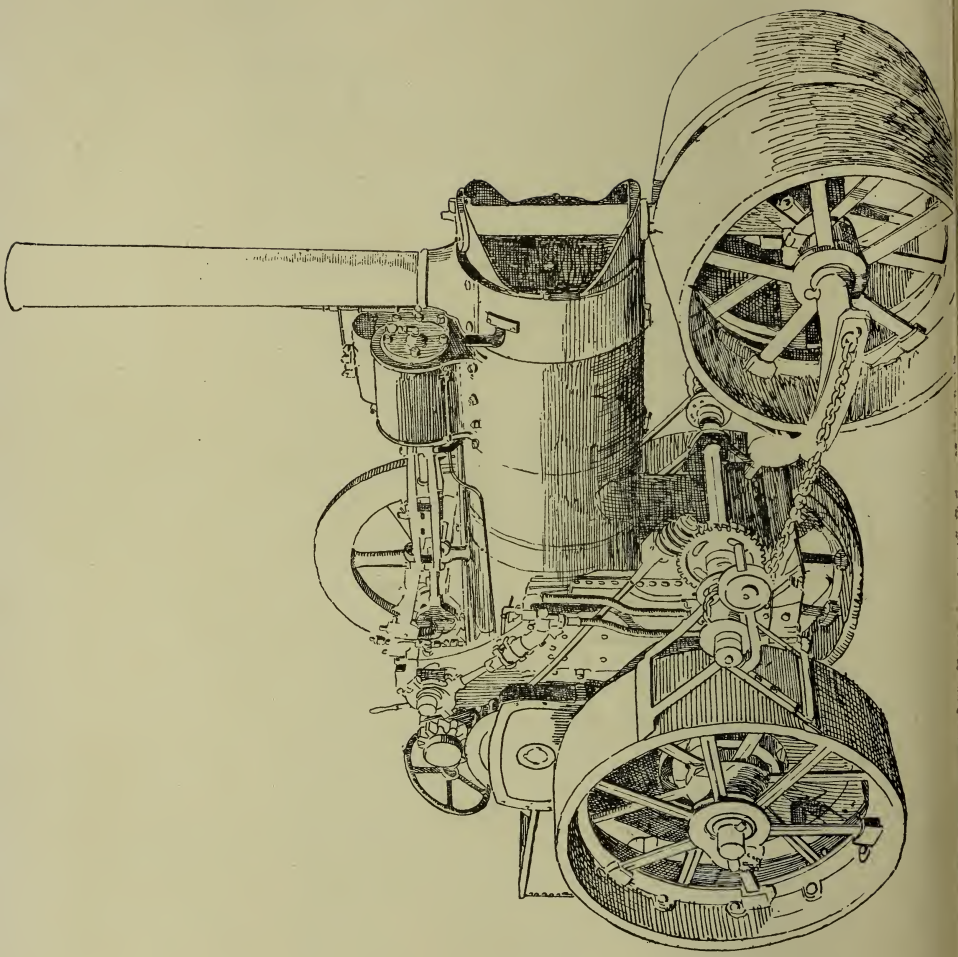


PLATE IX.

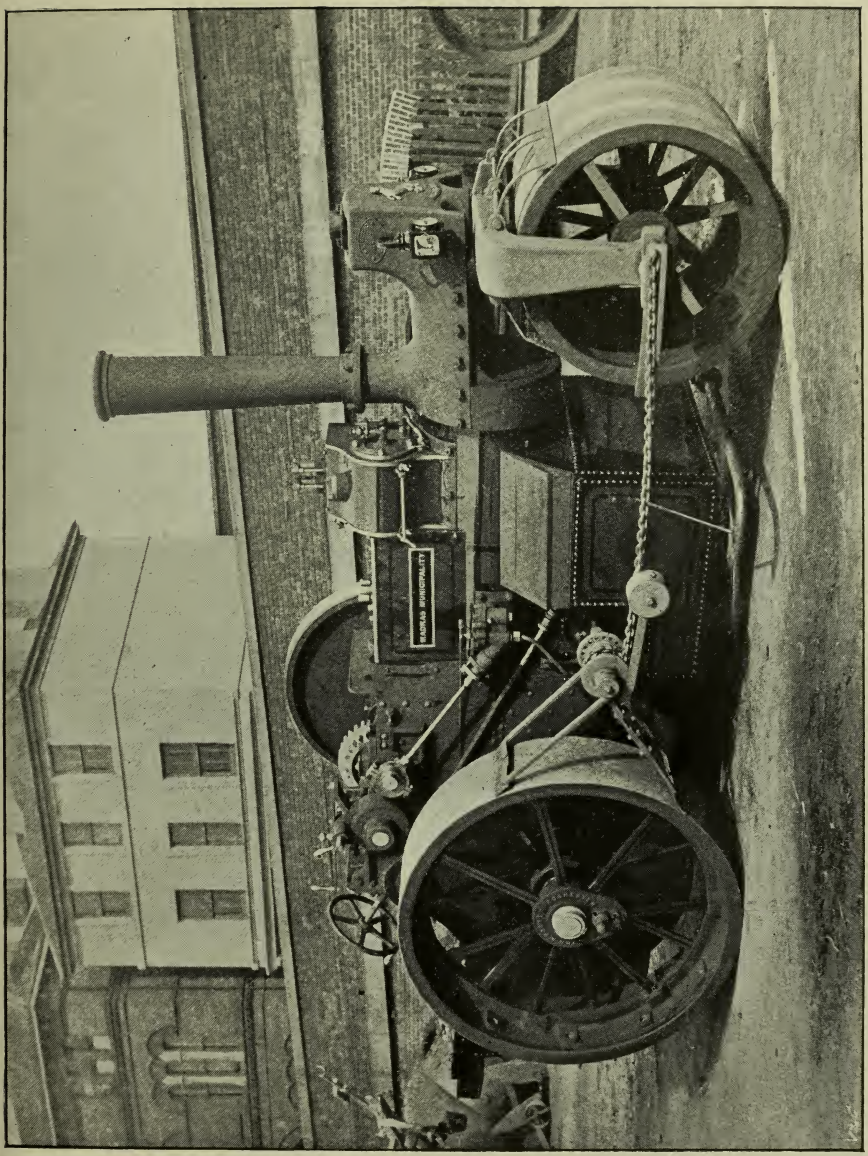
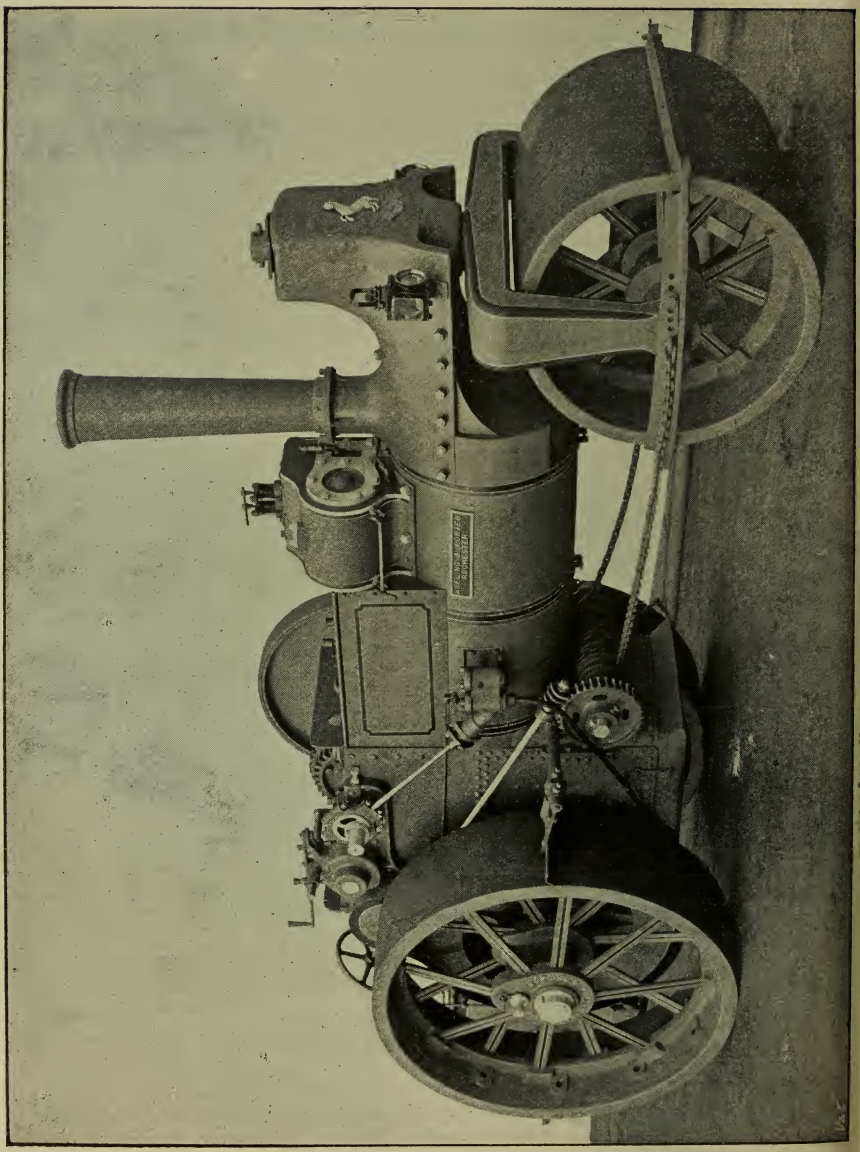


PLATE X.



and so fitted as to avoid all rattling after a little wear, is almost impossible; the turning may be excellent, and the hopes good, but the practice is bad, and new wheels, and only new wheels, are the present remedy.

Steel wheels have been tried, but always found to be useless when worn, because of the polished smooth surface they presented, causing the roller to slip and being practically useless on the slightest incline.

The best cast-iron wheels still are best, and these must be of such quality and hardness as to withstand as far as possible the ordinary wear and tear, but at the same time to be sufficiently soft as to bite and prevent slipping when travelling up or down steeper gradients.

The Author here has not touched upon spiked wheels or scarifiers as attached to rollers. The very exhaustive paper read at Reading will be fresh in the minds of all. His experience is that for county work these auxiliaries are unnecessary, and ordinary well supervised manual labour is sufficient for the purpose.

Before turning to the uses of this useful adjunct to road-makers, as a record, the Author feels he must present an illustration of the latest and best type of roller for county work (see Plate X.), such as now made by Messrs. Aveling and Porter of Rochester, a firm capable of turning out as many as 300 rollers per annum, and makers of the compound rollers now used throughout Notts. It is briefly described as follows:—

Weight about 12 tons.
Bearing weight on road 401·2 lbs. per square inch.
Length over all, 18 ft. 6 in.
Width of roller surface, 6 ft. 5 in.
Height to top of funnel from ground, 9 ft. 10 in.
Six horse-power nominal.
Driving wheels, 5 ft. 6 in. diameter, 1 ft. 5 in. wide.
Front rollers, 4 ft. diameter, 2 ft. wide.
Boiler made of special brand milled steel.
Plates flanged by hydraulic flanging press.
Large grate area and heating surface.
Gearing made of fine crucible cast steel.
Crank and intermediate shafts carried by patent steel brackets.
Sides of fire-box being extended to form brackets.
Constructed with feed pump and injector for filling.

Special note should be made of the advantage of the fire-box being extended to form the brackets, because it allows the gear to be brought closer together, thus reducing the width of the roller,

so that whilst narrow lanes can be rolled easily, the shape of the road is retained.

Having thus far written only on the history of steam rollers, the Author would now turn the attention of the Association to the working of the rollers and their general usefulness.

There are but few urban councils of any size or pretension to importance who do not possess or hire a steam roller for some period at least of the year, but there *are* still councils who look upon steam rollers with a contempt commensurate with the ideas of our ancestors, who objected to railways coming near their towns because the advent of railways would spoil their trade on the river.

The Author claims for himself some experience of the early days of country steam rolling, and well remembers the objections that were urged by those self-opinionated "members" who generally know, in their own estimation, far more about roads than their surveyor is paid to know. No portion of England is now better served with steam rollers than the birthplace of rollers, Kent, and for once the old adage as to the shoemaker's wife does not hold good.

The objections first urged against rollers were—

(*a*) More material would be required.

(*b*) The material would be smashed.

(*c*) More dirt would exist.

(*d*) The roads would be so smooth as to be dangerous in winter.

(*e*) All the drains would be broken in.

(*f*) The cost of the roads would greatly increase; and

(*g*) More expensive material would be required.

At the present time, although so many councils use steam rollers, yet, judging from the endless questions the writer receives on this subject, there are a vast number of councils, and, the writer is sorry to say, surveyors as well, who know but little of the good results of steam rolling other than the knowledge which they are so often loth to admit, viz. that "such and such a council has better roads than we have."

Dealing with these objections as they occur, the writer will do his best to once more meet them.

(*a*) No more material is necessary than as of old at any given period. It is as easy to patch with a steam roller as without one, and the result of the two attempts will be found at least 60 per cent. cheaper in favour of steam rolling. No material wears out so quickly as the isolated patches placed on a county road and

left to "settle" according to the traffic and nature, and no patches do so much damage to the remainder of the road as these patches neglected. The traffic avoids them, the outside edges are always liable to be chipped, whilst avoiding the patches the remainder of the surface of the road receives more than its due share of the traffic, and consequently the weaker sides are cut through while the stronger centre is being patched. A steam roller patch is placed exactly where it is required at once, causes no inconvenience, no waste of material, and instead of costing day wages for raking or covering, costs possibly something under 1*s.* per ton weight of material as against about 2*s.* for attendance and blinding, if the latter luxury is adopted by a council so short-sighted as to ignore steam rolling.

(*b*) The material is not smashed if a patch is properly prepared. The Author adopts the principle of always wetting the road before applying material, and opening the edge of the hole before covering with a patch, removing the fine detritus, applying the material of the gauge required, and covering the edges up with the removed detritus, blinding, well watering, and finally well consolidating the whole with a roller. The Author gives directions, which his foremen strictly carry out, that no patches are to be applied without the steam roller, and the road prepared in the way named; as a consequence, unless the roads are actually under repair, any one can drive over 300 miles of main roads in Notts, without being inconvenienced by any loose road material.

(*c*) Instead of more dirt existing from the supposed smashing of material, there is considerably less, because with roads prepared as before stated, the material is consolidated whole by a roller, instead of kicking about and becoming chipped and generally disintegrated, as is the case without one.

(*d*) Steam-rolled roads most certainly have a smooth surface, but instead of this being urged against steam rolling, it appears, and always has appeared, as a strong point in favour of it. The short period of really slippery weather in winter, when a few loads of ashes or road scrapings will make the road safe, is of slight importance when compared to the great saving to horses and carriages, and the comfort of say eleven months of dry, clean, smooth roads to one month of slipperiness.

(*e*) With the present use of traction engines and large boilers, &c., that are being constantly carried over our roads, any drains that may be damaged by a steam roller would be equally likely to be damaged by these other heavy weights, and the number of

shallow drains in country places must in time be gradually altered to suit the needs of an ever increasing population. All new drains under the roads in the county of Notts have to be laid in accordance with the following requirements:—

"When road material or foundation is taken out, it shall be properly sorted, and any portion that may be soft or wet shall be entirely removed from the roads. The trench shall be refilled with as much of the dry material as the county surveyor shall consider fit for the purpose, providing always the foundation of the road shall be made up with four inches of hard dry core, cinders or rammel, with a final coat, four inches thick, of new good sound metalling, similar in character to that of the existing road. As each layer of the new filling-in and road surface is made, it shall be thoroughly well rammed. Should any unevenness afterwards occur, the road surface shall be made good with approved sound road material.

"Pipes and drains laid beneath any road under the jurisdiction of the Notts County Council shall, if within three feet of the surface of the road, be covered with at least six inches of concrete surrounding the pipes or drains, or the pipes or drains shall be constructed of iron. It must be clearly understood that all pipes and drains shall be laid so as to allow a steam roller being used at any time over same, and the council shall be held free, in case of any accident happening to the pipes or drains, the cost of reinstating any pipe or drain that may be broken or damaged being borne by the authority, company, or persons laying or owning the pipes or drains."

The few drains that have been damaged in Notts have usually been those that really required abolishing by reason of their very bad condition, and should never have been allowed to exist.

(*f*) The increased cost of roads need not at any time exist through steam rollers, unless there is some great reason for such increase, but that at first bad roads are most expensive is only too well known to those surveyors who have councils who want everything done at once. The Author's experience is that only careful judgment is needed to avoid this. Let the year's material be apportioned as usual, and avoid coating or sheeting as far as practicable the first winter, allowing the roller to work and compress the uneven roads into as fair a shape as possible during the wet weather, and when the second year's material is to hand, commence a graduated system of coating (according to the importance of and

traffic on the road), so that the whole has a two years' start, those roads most needing it being the first to receive the coating and rolling. In a given period, the work can so be arranged as to allow of every road receiving its proper share of material and the whole having the necessary covering, a system that is absolutely impossible without a steam roller.

(*g*) A generally heard statement is—"It is no use rolling our stone." The Author's answer has invariably been—"Then your stone has no business to be placed on the road at any time." If material will not stand a steam roller, on a road properly prepared, it certainly will not stand the ordinary traffic, and the use of this bad material is the most wasteful and expensive way of maintaining any used highway.

The Author uses 12-ton rollers, on magnesian limestone for sides of roads, furnace slag for making up important roads and coating second-class roads, and granite for coating first-class roads. He has successfully used similar rollers on Kentish ragstone and flint, and by testing has found that material so consolidated does not give off by 25 per cent. so much dirt and dust as materials consolidated by the old-fashioned method of raking in.

Many other so-called objections against rollers will occur to the minds of Members of this Association, but those here touched upon are those principally urged. One other must, however, be mentioned. Some of our Members will remember a correspondence that took place in the 'County Council Times' about five years ago relating to highway management. The Author was much struck with the insane suggestion that roads in England should be punned or rammed by hand as in Ceylon, instead of being steam rolled, and was quite prepared for the cost of this ramming, which the author of the letter stated to be some 2*l*. per ton of material consolidated; and yet this was urged as preferable to steam rolling, and had been seemingly suggested by some one who posed as an instructor on road-making to surveyors in general.

It is quite an error of judgment to imagine that the heavier a roller the better the work. A 12½-ton roller is the most useful and reliable implement the Author has had to use, and strongly advocates that weight to those who are adopting the use of steam rollers. Heavier rollers do more damage to material and drains, and in the end prove cumbersome for country districts.

Turning from these "objections" to the recognised work of a steam roller, the following may be considered the general work

allotted to the machine, although when a roller is to be purchased some enthusiasts go too far, and not only overrate the possibilities of the machine, but disappoint those who would be satisfied if such extraordinary capabilities had not thus been claimed, but ordinary results fairly stated.

The recognised work of a roller the Author would divide as follows, for country districts especially, viz.—

Consolidating weak roads liable to break up at any period.

Patching a wearing road.

Rutting a road cut through.

Coating and sheeting.

General traction.

Some of the most appreciated work the roller has executed for the Author has been the consolidation of roads that had previously been mismanaged with an excessive quantity of material. What can be worse than a road in an everlasting state of loose stone? Is it to be wondered at that the general complaints are loud and deep at the condition of the roads, and the consequent expense? Who does not know the county road, and, alas! the by-road in the urban district, that has for its chief figure long lines of ruts, the heaped up material on either side of those ruts, the weary, expensive and irrational "raker-in" constantly at work, and more constantly abused by every one? To this state of roads an end can easily be made. The material should be raked in, and the road levelled as well as it can be at once, the roller then applied and careful rolling commenced from the sides to the centre, and without the application of any fresh material a level road is presented free from rough stones and ruts. If the rolling is sufficient, the good result is, that no further ruts will appear, unless of course the road is neglected, and it again wears badly. The main point is, that a good system has been commenced, the road is consolidated, and a level surface, the whole of which is available for traffic, is presented, instead of the deep, miry ruts so long a nuisance previously. The cost of this work has been about 9*d.* per ton of material consolidated, and as a ton of 2¼-inch material spreads about fifteen square yards of road surface one stone thick, the cost of the rolling may be fairly stated to have been about ½*d.* per square yard. Compare this result with the manual labour in consequence of the many times raking in, and compare the material rolled in when first applied, with the material after it has been raked in, say six times, and is still loose.

Patching a road can be beautifully carried out by a skilful workman with a steam roller. Nothing can be worse than the state of a road "patched" with loose stones. Nothing is more likely to bring horses to grief. Nothing is more wasteful in road maintenance or calculated to irritate a person driving, riding or cycling.

Every one knows the old-fashioned "bound to turn out" patch, and the wretched bar system of compelling traffic to go so far over rough stones, to be turned on to another rough patch further on. Every one who has had to manage such roads knows the result, and comparing the cost of materials consolidated by the steam rolling and the "turning out" method, there is at once a great saving in favour of steam-rolled roads.

For further comparison, the Author gives the cost of the first road he had so to deal with, leading out of Nottingham and extensively used by coal carts. The cost of the three items of materials, manual labour and steam rolling for the last three years, will be useful comparison for any one having to use his persuasive powers with an authority adverse through ignorance to the use of steam rollers.

The road is known as the Ilkeston main road; the figures given are for the usual repairs on a county main road, with the same kind of material year by year.

	1893.	1894.	1895.
	£ s. d.	£ s. d.	£ s. d.
Materials	454 16 1	406 18 3	396 4 11
Manual labour	140 9 10	106 14 11	98 16 10
Steam rolling	29 4 5	25 16 3	25 13 8
	£624 10 4	539 9 5	520 15 5

Can there be any clearer proof than this? And whilst the road has decreased in cost, it has improved in condition from a rough, rutty road, to a level country road, whereon can be seen at any part of the day some dozens of cyclists.

Rutting a Road.—Few modern surveyors would allow a road to rut, but unless a steam roller is used this can hardly be

avoided. When ruts are filled up without the use of a roller, we well know the invariable result. More ruts follow side by side in the same line, and again the second edition has to be treated similarly to the first, and so on. Now notice the difference in a steam-rolled rut. Take a road with the last rut well showing. Fill the rut up to its required face and roll it. Immediately the whole road is fit for traffic, and no fellow ruts appear. What can be clearer proof of the advantage of rolling, and the saving of material?

Coating and Sheeting.—Again referring to the old methods. How much of the surface of a road can be coated even on a busy thoroughfare, where, if anywhere, the traffic can consolidate the newly applied material, without more material being applied to regulate and level the surface, necessitating extra material where the original was sufficient, and piling up material where it is not wanted. How can a road have its proper contour retained? What is the result? A bumpy, uneven road, more than necessarily round and high in the centre, to allow of surface water escaping, and with weak sides that allow of the centre being cut through with the first excess of lateral pressure. Try the effect of rolling the same coating: the road is fit for traffic within as many hours as the hand regulated coat is weeks. There is no filling up or excess of material, and the whole road is available for use, for the centre is not too high and the sides are not too rough. The surface is much smoother, water freely leaves it, and mud and dust are not the chief component parts, to be expensive and needless later on.

Still dealing with county roads, who has not had to deal with narrowed roads, at times so narrow as to become most expensive in maintenance, through the continued following of vehicle after vehicle in the same track. How has this narrowing occurred? Mostly by material being applied to strengthen the roads at the sides, and never having been consolidated, lying rough, mud being scraped over it, becoming grass grown, and finally past siding, hence the consequent narrowing. If a road side requires strengthening (and how very many of our county roads do require such treatment), nothing is easier with a steam roller: the material can be coarser and cheaper, and yet serve its object, the packing of the material together and the rolling prevent the grass growing, and again leave the whole road complete for traffic.

The Author's experience is, that there is plenty of work for one steam roller on either about an average of 90 miles of mac-

adam main roads, 150 miles of district roads, or 50 miles of ordinary urban roads, to keep it regularly employed without any other work, for the very best work can be performed with this machine during the summer ; in fact, on county roads it is far preferable to roll during the summer than winter. The Author uses his rollers all the year round without any stoppages. It is only necessary to arrange that those roads nearest the best supply of water are left for summer work ; an occasional extra horse and cart for water will be more than made up by the extra hours all concerned can work. The water carting for three rollers, which took place on a total of 578¼ days during the year 1894–95, in Notts, was divided as follows :—

April	60	October	69½
May	55	November	35
June	62	December	44½
July	78	January (severe frost)	6
August	58¾	February (ditto) ..	13
September	60½	March	36

On comparing this with previous years, the numbers vary so little as not to be worth mentioning, yet Notts would not be considered an exceptionally well-watered county for such work.

The extra cost of watering is the one principal charge brought against summer work, but the advantages of longer hours, immunity from after-damage by frost, with the consequent licking up as factors for counterbalancing, are seldom mentioned.

General Traction.—In some districts time can be spared for using a roller for other purposes, and traction work would undoubtedly be that which the writer would advocate, but not without a complete set of traction wheels. To attempt traction work with ordinary roller wheels is not calculated to be beneficial or desirable. Appliances for conversion are often suggested, but practical experience proves that alternative wheels alone are best.

General Working and Wearing.—In Notts, the working of rollers has been a most decided success. In September 1890, when rolling was first commenced, three rollers were purchased, and continued without intermission working for five years, each roller having, during this period, consolidated nearly 35,000 tons. It was then found necessary to send the three rollers into the maker's works to be completely overhauled, and whilst this was being done, as the wheels had become much worn, it was considered advisable to have a new set of wheels to each, although

the wheels would have in all probability stood another six months' wear without trouble. The total cost of this overhauling and new wheels was 388*l.* 18*s.*, equal to an annual expenditure of about 6 per cent., and the rollers are now practically as good as new. Under some councils a sinking fund is established to allow for this wear and tear, but in Notts this is not for several reasons adopted, much as the Author would advocate it where practicable. Upon the foregoing it will be seen an allowance of $7\frac{1}{2}$ per cent. would have been ample, instead of the 10 per cent. usually recommended for "depreciation."

The Author has often been asked, especially when giving evidence, as to the relative advantages of councils owning or hiring steam rollers. Without hesitation he would invariably answer in favour of owning them where the mileage is equal to that already mentioned, or where the driver can be usefully employed when the rolling work is not sufficient to keep him constantly at work.

Again, very often the Author has been invited to give an opinion as to the number of tons of material a steam roller should consolidate per day. So much depends on the stoppages, driver, and other causes, that no really definite number of tons can possibly be laid down as absolutely the quantity. In Notts we average thirty tons of material for each working day. Often it is good work in towns to complete twenty tons, but to say that any roller can properly consolidate seventy-five tons and over per day, as the Author once heard stated in evidence, is impossible. Again, the Author knows of a case where fourteen tons of material per day was really good work when allowance was made for the number of stoppages the roller was obliged to make for passing traffic. But in a case like this, surely it would be best to stop the traffic for the time being if in any way possible.

Steam rolling in Notts has cost annually about 650*l.* for the three rollers, or 217*l.* each, excluding the cost of the overhauling but including the cost of all other repairs, and, calculated on an average of seven thousand tons each roller has consolidated per year, brings the cost to nearly 8*d.* per ton, and if taken and compared with the annual saving on materials and manual labour, as compared with the days gone by, it will be found that, including all the work that is now carried out, a very great saving, with better roads, is the result. Before the main roads in Notts were taken over under direct control, the average cost per mile was 42*l.* 14*s.*, and not a stone left to repair a road that might give out. Whereas

in 1895 the same roads cost 54*l.* 11*s.* per mile, with material in hand value 13*l.* 13*s.* per mile, or a cost of 40*l.* 17*s.* annually, out of which the rollers working cost 2*l.* 7*s.* 9*d.* per mile; and the Author's candid opinion of the result is that it is very greatly, if not entirely due to the use of reliable steam rollers.

In conclusion the Author would apologise for the length this paper has assumed, but the subject is one in which he is so much concerned, that it is difficult to know quite where to leave off, and feeling there are so many others equally interested, he hopes the information he has here placed at the disposal of his hearers will repay them for the patience they have extended to him.*

DISCUSSION.

Mr. W. Weaver, in moving a vote of thanks to the Author of the paper, said: I think nobody going about the country can fail to be struck with the improvement which has taken place in the county roads throughout the country since the new Act came into operation, and without doubt, as Mr. Hooley says in his paper, the largest portion of that improvement is due to the fact of the roads being steam-rolled. We live in advancing times, when every road throughout the country has to be kept up to "bicycle excellence," and that is a standard of excellence which was not dreamt of twenty-five years ago. I do not propose to go into the details of the paper, but the only point I wish to touch upon is a question not dealt with in the paper, and that is the question of liability. It strikes me that all the surveyors throughout the country, including the metropolis, are placed in a somewhat difficult position with regard to steam rolling. I do not know whether you are all aware of the present liability for the use of a steam roller. Any one using a steam roller is liable for the damage done by that roller to gas and water mains, unless you can prove that the pipe damaged has been improperly laid. That is a very difficult thing to prove. If the company prove that their men did their work properly and laid the pipe in a proper manner, you have a very difficult task to prove that it was laid in an *improper* manner, and unless you can prove *that*, you are liable for damage. What I fear is that some day or other there will be a serious explosion, which will bring this question of liability before us in an un-

* The blocks illustrating this paper have been kindly lent by the Editor of the *Surveyor*.

pleasant way. It will not be a question of paying for damage to a few feet of main, but there will be a leakage of gas, followed by an explosion which may blow up two or three houses and kill two or three persons. Then that question of liability will be brought before the Association in a manner more directly than up to the present. In the paper Mr. Hooley gives preference to a 12½-ton roller. In London I think it is pretty universal now—owing to the difficulties we have in working the roller—not to go beyond a 10-ton roller. I used to have one 15-ton and three 10-ton rollers. After the six days' fight my Board had with the Gas Light and Coke Company, when the question of liability was settled in the manner I have indicated, we dropped the 15-ton roller—especially as it was nearly worn out—and went on using the 10-ton rollers. I find the 10-ton rollers make virtually as good a road as the 15-ton roller, and get through as much work. I agree with Mr. Hooley's figures as to the work done by the roller.

Mr. A. T. Davis, in seconding the vote of thanks, said: It affords me particular pleasure to say a few words about this paper, because my own experience coincides very remarkably with the experience of Mr. Hooley with regard to the results obtained from steam rolling on county roads. There are just a few differences in detail, but the main facts are precisely with me and my county as they appear to be with Mr. Hooley. In Nottingham, Mr. Hooley's experience is that thirty tons of material can be consolidated in a day. There is a slight difference in my case. I can do thirty cube yards; I think, perhaps that is a little better, because a cube yard is more than a ton. In fact it is at least 10 per cent. better. Then as regards the price of rolling per cube yard, Mr. Hooley puts it at 8*d.* per ton; my own cost comes out at 9*d.*, but the difference between the ton and the cube yard would account for that. I think throughout the country that would be a fair price. There are one or two other points that I rather differ from Mr. Hooley in. He seems to advocate patching, at least if he does not advocate, he speaks in praise of the practice of rolling patches. My practice is to coat a road in long lengths: in fact I endeavour to take the whole of a road and complete it throughout. When you commence to roll a country road it is impossible to carry that system out. At first it is necessary to patch it, but afterwards it is well to consolitate long lengths of material under the roller at one time. Mr. Hooley gives the mileage of country roads which can be efficiently rolled with one roller at

about 90 miles. My county is divided into six divisions, the mileage of which varies from 100 to 130 miles, and those districts of 130 miles are fairly well served by one roller. With regard to the weight, I quite agree with Mr. Weaver that a weight of 10 tons is all that is necessary, and my six rollers are of that weight; and I am pleased to say I have never had a case of a damaged water or gas pipe. When I have applications for statistics of steam rolling, I invariably recommend the use of a 10-ton roller. With regard to prejudice, of which Mr. Hooley speaks, it is surprising to know that even at the present day there is a prejudice against steam rolling, not only on the part of members of boards, but even on the part of surveyors. I think it is a matter of surprise at this time of day that surveyors should have any doubt as to the value of steam rollers. It is indeed astonishing how we could have gone on so long without a steam roller or a roller of some sort. I maintain that roads should be made for the traffic and not by the traffic.

Mr. W. J. Robinson: I wish to take the opportunity of urging the absolute necessity of having steam rolling in the making of our county roads in Ireland. In more than 90 per cent. of these roads no means can be provided for the use of steam rollers. Our rural roads are under the Grand Jury, and there is no means by which that authority can provide a steam roller. I thought it would not be out of place to throw out a suggestion that there should be some means by which a recommendation might come from the Association by which the law might be altered so that Grand Juries in Ireland might have powers to purchase rollers. Perhaps all the English Members may not be aware of the custom which exists in Ireland as to the making and repair of the roads. A contractor is under a contract to keep a road in repair for three or five years, and there is no means by which a roller can be provided. In these days of cycling it is unfortunate that the old system of making up roads by simply putting on the stone and allowing it to be consolidated by the traffic, should be still followed. It would be a very great boon to Ireland if the roads were properly rolled.

Mr. J. T. Eayrs said: If the repair of these roads is let by contract, I should like to know if there is any reason why a clause should not be inserted providing for the rolling of the roads by steam rollers.

Mr. W. J. Robinson: There would be every difficulty in the

way of such a clause. Perhaps some of our contract roads do not amount to more than 12*l.* or 20*l.*, and it would be impracticable to put a clause in such a contract providing for steam rolling.

Mr. W. Weaver: Why not keep a county roller?

Mr. A. E. Collins: I should like to reiterate the thanks and the remarks of appreciation to the Author for a very useful paper. I have nothing to add to it except this: I believe in a heavier roller where your roads are wide enough and the material is good enough. I get very satisfactory results from a 17½-ton roller, and I do not find the stones are crushed by it. I have not found that either the granite or the flint suffer by it. It has only been in use twelve months, but it rolls in very much more material than the 12-ton roller. Mr. Davis told the meeting that he had never caused any damage to pipes or mains, but if I remember right, a bridge suffered from the action of his roller. It may, however, have been the fault of the bridge and not of the roller.

Mr. C. H. Lowe: I have had considerable experience during the past thirty-five years with steam road-rollers, and I have never experienced any of the difficulties with regard to gas and water pipes to which Mr. Weaver has referred. I have three rollers—a 15-ton, 10-ton and 6-ton. I found the machinery of the 15-ton roller was very much damaged by going up steep inclines such as I have in my district, therefore I got my Board to purchase a 6-ton roller for light work. It would be very interesting if engineers would keep a record of the comparative cost of repairs of these rollers. I find that the heavier roller is more often under repair than the lighter one. I use the 15-ton roller on the making of new roads; the 10-ton roller for the second class granite roads; and the 6-ton roller for the lighter granite and small patch repairs. None of the rollers have much effect, so far as my experience goes, on the breaking or crushing of the granites.

Mr. Wellbourne: There is one suggestion made in the paper which strikes me very forcibly. Mr. Hooley suggests in time of frost the putting down of a few loads of ashes on macadam roads to provide a sure footing for the horses. I consider the putting of ashes on a macadam road as very detrimental to the road, as when the thaw comes it seems to lift up the macadam, and the ashes get into the road, and there is great trouble in cleaning it. I am now using gravel on my roads in frosty weather.

Mr. W. Brooke: The paper is a very useful one to every Member of the Association. I cannot quite agree with Mr. Davis

as to the weight of steam rollers. My twelve months' experience as a highway surveyor pure and simple, convinces me that the best roller to use is a 15-ton roller on granite roads and a 12-ton roller on hilly flint roads. Some of my parishes are contracted for, and I get the rolling done at 9*d.* or 10*d.* per yard. I find that the rolling done by my men costs 1*s.* per yard cube. The difficulty on the Kentish hills is the supply of water. If you have to cart the water some miles the cost of the rolling rapidly goes up. At Richmond I was always smashing gas pipes, causing little explosions and confusions in the roadways, and people wanted me to do no rolling at all in certain streets. I was in Dorset recently, where I saw some beautiful roads made without any roller at all. It was the condition of the sides of the roads which first drew my attention to them. I made some inquiries and was told that the surveyor was strongly against rollers. He is a Member of this Association. Steam rolling is one of the modern requirements, especially if you use a cycle, as I do. I should like some more statistics as to prices and the distance the water is carried.

Mr. E. J. Silcock: I should like to call attention to one small detail in connection with the paper. Mr. Hooley says he has not found any means of repairing the wheels of the rollers. There is one well known firm in the north of England who make steam rollers, who also make detachable rims for the wheels. I have found no difficulty in attaching these rims to the wheels, and they can be put on in a few hours.

Mr. W. Nisbet Blair: I have only one observation to make, that is, on the question of liability for damage caused by rollers. Of course we all admit that broken pipes and anything of that nature must be made good by the authority using the roller. But there is another source of action for damage, that is, with regard to the frightening of horses and consequent carriage accidents. We unfortunately have had to suffer in damages for an accident which occurred, although every precaution which is required under the Act of Parliament—the Highways Act—was taken. Our flagmen were out back and front; our roller was actually standing close to the side of the road, emitting no steam. The person was driving the horse towards the roller; he was warned of it, but he insisted upon making the horse pass it. The horse, a nervous animal, shied, bringing the cab up against the guard post, overturning the cab and injuring the driver and the fare, for which we

had to pay damages. The question would be whether it is not desirable that some additional legislation should be provided to protect local authorities in the exercise of their duty in the construction of these roads, and in order that they should not he harassed, as they are at present, by the state of the law, which gives every protection to other people, but absolutely none to the authority using the roller, though it is admitted that the use of the steam roller is an absolute necessity for modern macadam roads. You cannot protect yourself against such an accident as we suffered from, except by keeping the roller off the road altogether. I do not see that there is any possibility of taking any precaution beyond what we took, except by closing a road absolutely to traffic, and there are many roads where you have not a convenient side street down which you can turn the traffic; you are obliged to keep part of the road open, and the owner of the roller is responsible for whatever happens. If the Association would take the matter into consideration, and suggest some alteration of the law, it would be greatly to the advantage of all local authorities. Mr. Hooley mentions that the Nottingham County Council impose obligations upon people laying pipes in the roads to give an indemnity to the Council. I should like to know whether the Nottingham County Council have any authority for imposing such conditions. As far as I know, the statutory companies could resist such a condition. They are authorised by their statutes, whether gas or water companies, to lay mains in roads, and there is no power to compel them to lay in concrete. I fail to see how the Nottingham County Council can impose this condition.

Mr. Clarson: I should like to ask Mr. Hooley whether he has any experience of scarifying roads, and if so, whether he will tell us the result?

Mr. G. J. Hunt said: It is a matter of very great importance to us country surveyors, viz. the liability for the repair of broken pipes. In my district it is a cause of constant complaint. There seems to be no restriction upon the companies to lay the pipes any particular depths: in many cases they are less than a foot, and the consequences can be easily imagined. There should be some regulation as to a reasonable depth which we could ensure these gas and water mains being laid, otherwise it is imposing a great hardship upon the local authority to repair mains damaged in such circumstances. With regard to the Dorset roads, it is rather an

exception for rollers not to be used. In my district they are used, and I know also the county surveyor has adopted them. At the same time I know the neighbourhood referred to, and it is renowned for the capital roads maintained there. I believe gravel is the material used.

The PRESIDENT, in closing the discussion, said: I agree with a very great deal that has been said; in fact, there is quite a concensus of opinion as to the use of steam rollers expressed by the various speakers this morning. I am very much obliged to Mr. Hooley for bringing this paper forward, and also to Mr. Davis, another county surveyor, for giving us the benefit of his opinion. It is quite following out the idea suggested in my address on Thursday. I think it is very beneficial to the Association that the county surveyors and the surveyors of rural districts should give us the benefit of their experience. I am very glad indeed to see the county surveyors come forward to-day, and I hope it is a good augury for the future, and that many others will follow their example. I am sure the more information we get on this and other kindred subjects the better. The volumes of our Association are now becoming textbooks, and therefore the greater the variety of the subjects treated upon by the Members the more valuable they will become. To my mind it is one way in which we can make ourselves most useful to each other. With reference to rollers, I have had to use rollers from very early days. I had the privilege of using one of the first steam rollers made by Messrs. Aveling and Porter, the No. 12. That was a 15-ton roller. Here in Brighton we have one 15-ton and three 10-ton rollers, one being the new type of compound rollers. You will not be surprised at that after what I said yesterday as to not having any paved roads. We only use the 15-ton roller outside the town, where there are no gas and water mains. It will be within the recollection of some Members that Brighton did get into a difficulty some years ago owing to an explosion of gas, which was attributed to a steam roller breaking the main, as a roller passed over the road on the day previous to the explosion. The action was tried in one of the high courts, and the Corporation had to "pay the piper." That bears out the statement of Mr. Weaver. Since that action we have been debarred from using the 15-ton roller in the streets in the town, and we only use it in the outskirts and on new roads where there are no pipes. I believe the 10-ton roller is heavy enough for a flint road, indeed it is heavy enough

for any road. Where you use granite for macadam the 10-ton roller will do the work equally as well, but it takes more time than with flints. I am unable to give you any statistics as to the cost of rolling here. We work under very great disadvantages. In all our principal thoroughfares we are obliged to get our steam rolling done before 9 o'clock in the morning. We must not steam-roll at night, because we disturb the sleep of residents; and we have to get out before 9 o'clock, because the traffic of carriages to catch the early business trains is so great that it does not do to have the roads blocked. In my case half the time of my rollers is occupied in travelling to and from the work. Our roads are very hilly, so I find that puts a great deal of extra pressure on the engines. I have no doubt that from these causes the expense of repairs in our case would be abnormally high in comparison to the amount of work done. I hope in the future to be able to give such statistics as will be useful information to the Association. I am making arrangements by which I shall be able to have such work more immediately under my control so far as statistics are concerned.

Mr. E. P. Hooley, in replying to the discussion on the paper, said: I thank you very much for your kind reception of my paper. I hoped, when I wrote it, that it might be of some use to those who may possibly have to go through and to fight the battle of steam rollers against the ignorant, who object to any reform in management of any kind. I do not think it would be quite right to let it go forth that everybody has a right to claim for damage done by a roller. We in Notts have had claims and claims, but we have not paid many, and I do not think we shall. I hope in the time to come that all gas and water mains will be in the hands of one authority, and I don't think then any question will arise as to who shall pay for the damage done. Mr. Blair mentioned that we had not the right of saying how the gas and water pipes should be laid. I think he must have missed the point that the work must be done to the satisfaction of the local authority.

Mr. Blair: I question your right to compel statutory companies to lay their pipes in concrete.

Mr. Hooley: We say, "if you don't do it in our way you must put up with the risk." Mr. Davis has objected to one or two of my points. When you take into account the difference in traffic on roads in Shropshire and roads in Nottinghamshire you will appreciate his remarks. As to patching roads, I find it absolutely

necessary to do a certain amount of patching. If you don't do it you are not working on the recognised system. With regard to the question of weight, when the rollers leave the works they are nominally 12½ tons, but how long this continues is a question of wear. As to the question of putting on materials, I do not suppose it would do in London, but in the country we make this regulation. Our roads are managed by district foremen. We make these men sign an agreement that no material is put on the roads more than twenty-four hours in advance of the steam roller. If the material is put on, and we can prove it is the fault of the foreman, we fine him 5*s*. After he is fined twice we notice that a man does not make such mistakes. We use ashes on the roads in frosty weather because we have them given to us for nothing, and they do as well as anything. I find the ashes have a contrary effect to that stated by Mr. Wellbourne. The weather is a small matter; you do not get the weather continuously bad. If Mr. Silcock has been successful with detachable rims, he has been more sucessful than I have. I do not see how it is possible to properly put rims on a wearing-out wheel. After I have had such rims on for two months in Kent, there has been such a great rattle. On hilly roads I do not think Mr. Silcock would find the detachable rim much of a success. I shall always be pleased, if any member of the Association is in any difficulty, to give him the benefit of any experience I have; but I think it is most unfair for men to write all over the country and ask for returns of all kinds, and then the sender never hears any more about them. I have recently supplied five returns and have not received even an acknowledgment. I think, when Members of this Association ask for information, the least they can do is to acknowledge the receipt of one's letter, and if possible send a copy of the returns they receive from others.

W. H. Leete: As to the value of steam rolling over the old methods of working the stone in torturously by the general traffic, it would appear to one who has used such a machine for several years, that there can scarcely be any who deny its merits; but that many such persons do largely remain unconvinced, is no doubt owing to the fact that they have not themselves reaped the benefits from its use. I have found the most determined opposition in rural districts before the use of the roller, converted to almost unqualified praise. From my own experience I find a 10-ton roller quite heavy enough for county roads, from which I

have obtained good results both as to work done and the running cost of maintenance. I have occasionally hired a 15-ton roller, and have found insufficient advantage of the extra weight in surface rolled, but considerable jeopardy to the light-built structures that have been handed over to the county by the late highway authorities. The refacing of a road in sections is always desirable wherever it can be done. I have, like the Author, found the rolling in of tracks prevents others being formed and ensures a good traversable surface. As we are generally very poorly provided with water during the summer months, I find it more economical to cease rolling, and use the roller staff at general works of improvement and repair.

FOOTWAYS.*

By C. H. COOPER, Wimbledon.

Footways have in too many districts received little or no attention; in fact, it is not an uncommon occurrence to hear of public footways ceasing any longer to be available for public use.

Wet weather invariably renders a considerable number of country footways impassable for most pedestrians, although the cost of making up and maintaining such footpaths would add but little to the highway rates.

In order to maintain the public right of usage of footpaths through private property, and insure the full benefit of such paths, highway authorities should be compelled to put up a notice board at each point where a path intersects either a road or another path, stating where the path leads to, and an Ordnance map, say to a scale of not less than 25 inches to the mile, should be kept, showing the public paths distinct from other paths with a reference setting forth the paths.

Widths of Paths.—Rural highway authorities in many cases labour under the delusion that narrow paths effect an economy. In the Author's district considerable expense has been incurred in widening such paths. The width now generally allotted to each path on the side of a road is one-fifth of the total width of the roadway. There are no doubt cases, in which the traffic is exceptionally heavy, where it might be well to allow a greater width of carriageway.

New Streets.—Owing to the great inconvenience caused to the occupiers of houses in streets before they are dedicated as highways repairable by the inhabitants at large, the Author considers that before dwelling houses are erected in a new street, such street should be made up and taken over by the highway authority.

The occupiers of such houses would then have the full benefit of the rates they pay, as their road would be scavenged and kept in order in common with the other roads of the district; whereas at

* Reprinted by permission from Proc. Inst. C.E., vol. cxxii. pt. iv. p. 208.

present the occupiers of houses in private streets have, in too many cases, no proper footpath to walk on, and a carriageway full of large holes containing liquid which is little better than sewage.

Law.—It is not generally known that local authorities have no power, except where special Acts may exist, over the materials used in the construction of new roads and paths, and that it is not till a road has become a street that the local authority's power to compel the owners to make it up under Section 150 of the Public Health Act of 1875 can be enforced.

Channelling.—Although the channels do not form part of a footpath they are most important adjuncts. In the first place a channel protects the path against disturbance from rollers and wheels of carts using the carriageway. In the second place it affords drainage and prevents the path being saturated from the water table.

For the purpose of this paper it is not necessary to go into the construction of a channel, except to say that it should be capable of supporting whatever load may come upon it without causing the ground on which it rests to spread.

Kerb.—A great deal may be said in favour of flat kerb, which affords a substitute for paving where gravel paths are allowed to get out of repair. Flat kerb is more liable to be displaced than edge kerb, but this liability can to a great measure be removed by placing the kerb on a bed of concrete. Unless such kerb is omitted for lamp-posts, posts come too far into the path.

The Author prefers 8 inches by 12 inches edge kerb for main roads, and 6 inches by 12 inches edge kerb for ordinary roads. The stone that stands best is Aberdeen granite, but owing to the reduced price at which Norway granite is delivered in the London market, little Aberdeen is now used in and about London. Newry and Cornish granites are used, but neither are well dressed, and, so far as the Author has seen, both are coarse grained.

Guernsey granite is used in some districts, but as it is very hard it becomes slippery, and can only be procured in short lengths.

The Author has had experience of Purbeck, Keniton, and Pennant limestones, but with the exception of the latter he has not found limestone to last as kerb. Pennant, moreover, varies so much that its use in Wimbledon has been discontinued.

Foundations.—Although, on dry gravel or sand, foundations for

paths may as a rule be omitted, on other ground the foundation becomes the principal part in the formation of a path.

The Author prefers a layer of furnace ashes, or, in the case of concrete *in situ*, furnace clinker, to any other material that can be easily procured about London. A layer 4 inches thick of either material affords ample drainage, and prevents frost penetrating the soil beneath so as to disturb the path. The foundation should be well rolled, and exposed to traffic as long as possible before the paving is laid.

Every care must be taken to cut off all springs, and any water that would be liable to soak under the path, and for this purpose it may be necessary to lay a rubble drain at the back of the path.

Table A gives a tabulated statement showing the various path coverings and their comparative cost, a description of each of which it is proposed to give in the same order as in the table.

Stone.—For paths which it is not intended to pave, a layer of fine binding gravel about 4 inches in thickness is generally placed on the foundation previously described, and well watered and rolled. Although such a path may answer in certain dry situations where there is not much traffic, it becomes a matter of impossibility to maintain it in a satisfactory condition in low-lying districts where the traffic is considerable. Gravel never forms a pleasant path to walk on, and is most expensive to keep in order.

Stone Slabs.—The use of natural dressed stone (York) has been discontinued in the Author's district for many years, on account of its excessive first cost and uncertainty as to wearing qualities. York stone laid sixteen years ago was removed in 1894, the greater part of the flags being worn through ; whereas concrete slabs laid some eleven years have not worn $\frac{1}{8}$ inch, although subject to quite as much traffic as the York stone.

The weather, apart from the effect of traffic, affects York stone, causing the stone to laminate and disintegrate. This result may be seen in the case of the York flagging laid in front of the National Gallery, Trafalgar Square,* and in front of the British Museum, Great Russell Street. In neither case is the York stone subjected to traffic, yet it is reduced in places more than 1 inch in thickness.

Concrete Pavings.—The materials used to form the wearing part of most concrete pavings, whether the concrete is formed into slabs or laid *in situ*, are practically the same, viz. granite broken to

* This flagging has recently been removed.

TABLE A.

	Paving.	Materials of which Paving is composed.	Thickness of Paving.	Cross fall required per foot of width.	Life of Paving.	First cost of Paving per yard super.	Annual maintenance per yard super.	Total annual cost per yard super.	Remarks.
			Inches.	Inch.	Years.	*s.* *d.*	*d.*	*d.*	
	Gravel	Fine binding gravel composed of small flints.	3	$\frac{1}{2}$	3	1 0	1	$5\frac{1}{2}$	As this material is never subjected to heavy traffic, its life probably is much less than stated.
Flags.	York paving	Sandstone	3	$\frac{1}{4}$	15	7 6	..	4·54	
	Victoria stone	Leicestershire granite, Portland cement and silica.	2	$\frac{1}{4}$	The Author has no means of determining the maximum life of these pavements, none of which could be less than 30 years if subjected to such traffic as occurs in most towns.	6 0	..	3·68	Victoria stone laid in 1884, outside Wimbledon railway station, wore less than $\frac{1}{8}$ inch while subjected to an average traffic of 40,000 persons per week (now over 50,000).
	Imperial	Various granites, Portland cement and silica.	2	$\frac{1}{4}$		5 8	..	3·47	
	Stuart's granolithic	Aberdeen granite, Portland cement and silica.	2	$\frac{1}{4}$		5 6	..	3·37	
	Adamant	Aberdeen granite concrete compressed.	2	$\frac{1}{4}$		5 3	..	3·22	
In situ.	Imperial	Various granites and Portland cement.	2	$\frac{1}{4}$		3 9	..	2·31	
	Stuart's granolithic ..	Thames ballast concrete, Aberdeen granite concrete	2 1	$\frac{1}{4}$		3 8	..	2·26	
	Guernoid	Guernsey granite concrete	2	$\frac{1}{4}$		3 6	..	2·15	6*d.* per yard allowed more than contractor's price.
	Candy's bricks	Devon granitic clays ..	2	$\frac{3}{8}$	10	3 $4\frac{1}{2}$	..	4·75	
	Blue Staffordshire bricks.	Staffordshire clays	2	$\frac{3}{8}$	12	3 $1\frac{1}{2}$	..	3·77	
	Buckley bricks ..	..	2	$\frac{3}{8}$	14	3 0	..	3·19	The traffic allowed for in this table is much more than is generally borne by tar paving.
	Tar paving	Limestone, gas tar and pitch.	3	$\frac{3}{8}$	10	2 6	$\frac{1}{2}$	4·02	
	Asphalt	..	concrete 3, asphalt $\frac{3}{4}$	$\frac{1}{4}$	12	6 6	..	7·84	In this case the cost of concrete is repaid in 12 years.

the size of pea-gravel, i.e. $\frac{3}{16}$ inch in diameter; Portland cement ground fine and well cooled; and in many cases a solution of silicate of soda.

The slabs laid in the Author's district comprise those manufactured by the following companies, viz.:— The Patent Victoria Stone Company, Stuart's Granolithic Company, The Imperial Stone Company, and the Adamant Stone Company.

Concrete Slabs.—The granite used by the Victoria Company and Stuart's Granolithic Company comes from Leicestershire, whereas that used by the Imperial is a mixture of Aberdeen, Guernsey and Quenast (Belgium), with all fractural dust removed, which is said to increase the strength from 15 to 20 per cent. This statement is not borne out by the Author's tests, see Table B, which shows that the removal of the fractural dust by washing slightly weakens the concrete.

TABLE B.—Concrete Tests.

The test briquettes were 2 inch by 2 inch sections, made from Aberdeen, Guernsey and Leicester granites, of various sizes, 3 of granite to 1 of cement by measure. The cement used was all taken from the same bag, and gave, when mixed neat, after seven days, a tensile breaking strength of 470 lbs. per square inch, and left $7\frac{3}{4}$ per cent. residue on a sieve of 5800 meshes to the square inch. The briquettes set one day in water and twenty-seven days in air, with a damp cloth over.

Size of Granite. Aggregate.	Aberdeen. Average breaking strain in lbs. of 3 briquettes.		Guernsey. Average breaking strain in lbs. of 3 briquettes.		Leicester. Average breaking strain in lbs. of 3 briquettes.		Average breaking strain in lbs. of briquettes made from various sized granite, irrespective of kind.	
	Washed.	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed
2 measures $\frac{3}{8}$" 1 do. $\frac{1}{8}$"	417	593	360	400	330	327	369	440
All passed $\frac{1}{4}$"	517	467	533	483	333	376	461	442
Do. $\frac{3}{16}$"	620	585	430	550	300	290	450	475
Do. $\frac{1}{8}$"	373	380	293	257	306	273	324	303
	1927	2025	1616	1690	1269	1266	1604	1660
	Strength decreased by washing aggregate, 4·8 per cent.		Strength decreased by washing aggregate, 3·8 per cent.		Strength not affected by washing.		Strength decreased by washing aggregate, 3·4 per cent.	

The Imperial Stone Company form their slabs on a table which is constantly jumped up and down by the rotation of a cam placed under the pillar supporting the table. This constant jumping gets rid of a number of air spaces, and is said to produce a more uniform slab than can be made by hand.

The Adamant slabs for street paving have so far been manufactured from Aberdeen granite, although it is contended that the process adopted by the company is capable of manufacturing slabs from almost any stone ; certainly those manufactured from crushed York stone appear very suitable for footways.

The proportions in which the cement and stone are mixed is stated to be nearly the same in all four cases, namely, 1 of cement to 3 of stone. While the slabs made by the first three companies are immersed in a bath containing a solution of silicate of soda, the Adamant Company subject their slabs immediately the concrete is placed in the moulds to a pressure of 10 cwt. to the square inch, which is said to remove all air cavities and to produce a stone that is of uniform texture and easily worked. The Author having tried the stone, his authority procured the bankrupt stock of the former Adamant Company ; 1200 yards of these slabs were laid during 1893, and 2000 yards during 1894. The slabs were conveyed at the company's risk, and were for the most part packed on edge across the trucks, so that many got broken in transit, and others no doubt were cracked although the cracks were not visible. Yet amongst those laid the number cracked is much less than in the case of any of the other slabs except the Imperial. See Table C, which gives the percentage of the various slabs laid in Wimbledon which cracked.

TABLE C.—Slab Paving.

Name of Paving.	When laid in Wimbledon.	Yards super. laid.	Number of slabs cracked.	Per cent. of slabs cracked to yards laid.
Victoria	1884–1886	975	25	2·56
Imperial	1889 and 1893	665	6	·90
Stuart's Granolithic ..	1892	900	19	2·11
Adamant	1893 and 1894	3200	21	·66

With the exception of the Victoria stone, none of the concrete slabs have been laid for a sufficient time to show apparent wear.

Much depends on the way in which slabs are laid. Good foundations should be provided, with a top layer of fine material, either sand or ashes; on this a layer of poor hydraulic lime mortar is spread, on which the slabs are bedded. It is important that no part of the slabs be left unsupported.

In no case should slabs be allowed to lap more than 8 inches, and it is well if two sizes of closures are used, so that the joints on either side of a slab are not opposite one another (see Fig. 1).

When slabs lap so as to break joint on either side of the centres of the intervening slabs, it is a common occurrence to have several slabs split across the centre for a considerable distance.

The slabs when laid should be run in with grout made from mortar similar to that used for bedding.

Concrete Paving in situ.—Concrete paving *in situ* was first laid in Wimbledon by the Imperial Stone Company in 1884, on the west side of Wimbledon Hill. When the hill was widened in 1892 this paving had to be removed, and was relaid in Denmark and South Roads, few of the panels being damaged. This is the only case of paving *in situ* being relaid that has come to the Author's notice.

In relaying *in situ* paving, a space of about 3 inches should be left between the panels, which can be filled in with concrete so as to allow for the edges of the panels not coinciding.

The Imperial Stone Company lay their concrete for *in situ* on a foundation of 4 inches of clinker or brick rubbish, in one coat sufficient to give 2 inches in thickness when finished, without the addition of any surface coat; the fine material being brought to the surface by trowel tapping. Screeds are formed on the foundation with wood strips 2 inches by $\frac{1}{4}$ inch, placed from 6 feet to 4 feet apart across the path. Into each alternate bay formed by the screeds, granite concrete is placed and well worked so as to remove all cavities, and the face trowelled off smooth. After the panels thus formed have well set, the intermediate bays are filled in and worked in a similar manner, the wood strips being left in so as to prevent the panels adhering to one another.

Except on inclines, the Imperial Stone Company do not indent the surface of their paving, as such indentation is considered to interfere with its wearing qualities.

There is no doubt that such a homogeneous layer as the Imperial Stone Company provide gives great strength, and at the same time provides wearing material throughout the entire depth of the concrete.

Mr. Butler, of the Imperial Stone Company, informed the author that while he allowed the sun's rays to act on cement where it was stored, he found the strength of the cement deteriorated. He therefore excluded the sun's rays and has not since observed any such deterioration.

Stuart's Granolithic.—The *in situ* paving laid by Stuart's Granolithic Company, consists of a bottom layer of Thames ballast concrete 2 inches thick, laid on a foundation of 4 inches of clinker or brick rubbish. On the ballast concrete a layer of granite concrete 1 inch thick is laid, each layer being well worked so as to remove cavities ; the surface of the last layer is trowelled to a fair face, which is then sanded and rolled with a spiked roller, which indents the surface and so tends to prevent slipping.

The concrete is laid and finished off in panels as in the case of Imperial stone, except that the wood strips are omitted in the finished paving.

The Author has tried corduroying on inclines, so as to give more foothold than the indented surface, but it is very difficult to get men up to the use of the corduroy roller.

Guernsey Granite Concrete.—In 1894, the Author laid 13,700 yards super. of granite concrete paving 2 inches in thickness. This paving was laid on a foundation consisting of the gravel which formed the old path ; or where such gravel was not 4 inches thick the deficiency was made up with furnace clinker.

The concrete consisted of Guernsey granite chippings and Hilton and Anderson's cement ; it was laid in two layers, the first, $1\frac{1}{4}$ inch thick, composed of chippings that passed through a $\frac{3}{8}$-inch mesh and were retained on $\frac{3}{16}$-inch mesh, mixed with cement in the proportion of 4 of chippings to 1 of cement. For the top layer, $\frac{3}{4}$-inch thick, the chippings were finer, passing through a $\frac{3}{16}$-inch mesh, and cement was added in the proportion of 1 of cement to 2 of chippings. This layer was placed on the bottom layer within half an hour after the bottom was laid. Each layer of concrete was well worked after being placed in position, the surface of the top layer being trowelled off perfectly smooth. The Author kept the panels apart by flat iron bars which were withdrawn after the concrete had been placed in position, and

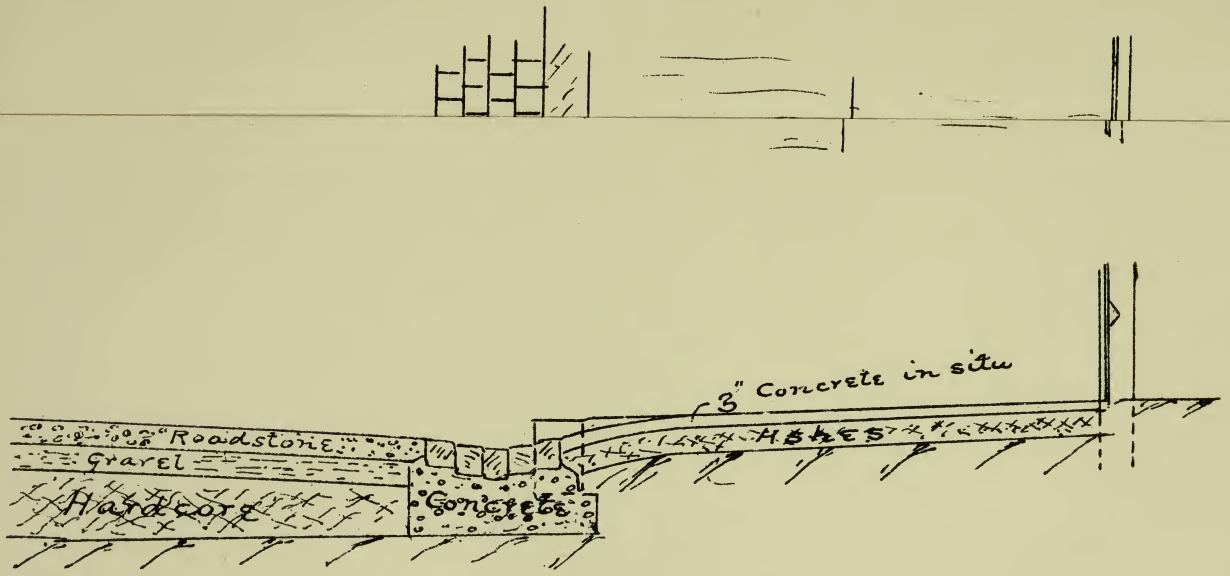


FIG. 3. CROSS SECTION

FLAG PAVING

LAID SO THAT JOINTS ARE NOT OPPOSITE

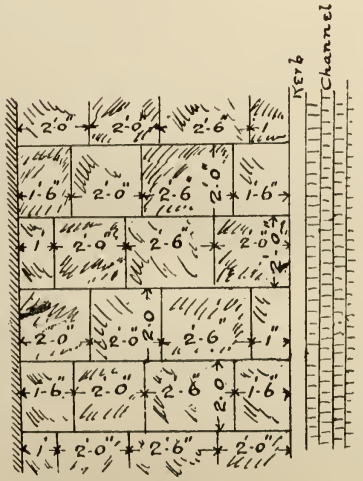


FIG. 1.

CARRIAGE CROSSING

PAVED WITH CONCRETE IN SITU.

SCALE 3/8" TO 1'0"

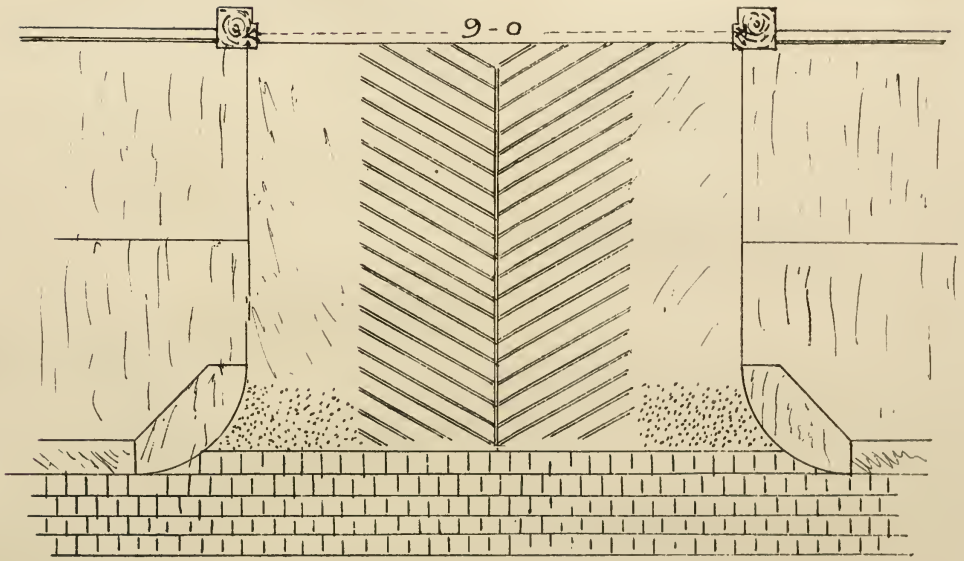


FIG. 2. PLAN

FIG. 3. CROSS SECTION

strips of wood 2 inches deep and $\frac{1}{8}$ inch thick were then inserted before the face was trowelled off.

Messrs. John Mowlem and Co., of Millbank, S.W., were the contractors who carried out the work, and much credit is due to them for the pains they took in connection therewith.

Carriage Crossings.—In laying carriage crossings, the Author has for some years dispensed with the usual drop, the crossing being laid at the same level as the path except where it slopes to the channel, the kerb on either side being stopped off with a quadrant (see Figs. 2 and 3).

Such crossings are laid in concrete 4 inches thick; and the surface after being trowelled off is grooved in a herring-bone pattern, the grooves being placed about $3\frac{1}{2}$ inches apart so as to afford foothold for horses.

In all concrete paving the materials used should be perfectly clean, of fairly uniform size, and the cement finely ground and cool. *In situ* work cannot be done in frosty weather, and to protect fresh panels against rain and sun, cloths must be used. During dry or hot weather it is important that the panels are kept constantly wet for at least a week after being laid, during which week all traffic must be kept off.

Brick Paving.—The appearance of brick paving is not in its favour, nor does it afford a pleasant surface to walk over. At the same time it has many advantages, and is well suited for such streets as are met with in manufacturing discricts, where well burnt bricks last for a long time. They can be removed and relaid at a small cost without interfering with the appearance of the path. This is a great point in their favour, especially where a path is liable to be disturbed by house connections.

The brick pavements laid in Wimbledon rest on a foundation of furnace ashes, as previously described, with a layer of fine sand about $\frac{3}{4}$ inch in thickness, which forms the bedding material on which the bricks are laid. The bricks are placed as close together as possible, and run in with sand and water.

Three kinds of bricks have been tried, viz. the imperishable granite vitrified paving brick made by Candy & Co. from Devonshire clays, the blue Staffordshire, and Parry's Buckley brick made near Chester.

Imperishable Granite Vitrified Bricks.—The imperishable granite vitrified paving bricks were laid in 1883 and 1884 on the east side of the broadway and part of the same side of Hartfield

Road. These bricks are of a light buff colour, which presents a more pleasing appearance than blue bricks. They are manufactured from granite clays found in Devon.

Although the bricks laid in Wimbledon cannot be said to have worn as well as either the blue Staffordshire or Buckley bricks, those laid in Leadenhall Street, near the entrance to Leadenhall Market, show much less wear than the York stone which joins the brick paving, not only at the end but also in the stones which receive the coal plates, &c., placed in the paving.

Blue Staffordshire Bricks.—There are two serious defects in blue Staffordshire bricks, viz. :—

(*a*) The surface is so vitrified as to be slippery.

(*b*) As a rule the bricks are not burnt throughout, so that when the exterior blue coating is worn through, the red central core of the brick offers little resistance to wear.

Buckley Bricks.—The Buckley bricks, although not showing the same vitrified glossy surface as is met with in the blue Staffordshire bricks, are much more evenly burnt, as a rule the entire brick being vitrified throughout, while the surface retains sufficient roughness to give a foothold. These bricks are slightly larger than the general run of Staffordshire bricks, being 10 inches long by 5 inches broad by 2 inches deep, whereas both the Staffordshire and Candy's bricks are 9 inches by 4½ inches by 2 inches. The author prefers the larger size brick, not only on the score of economy but also from the fact that it forms a pleasanter surface to walk over.

Brick Crossings.—The Author has tried brick crossings with bricks 4½ inches deep, but although such crossings answer well for light traffic, they cannot resist the wheels of heavily laden vehicles.

Tar Paving.—The manufacture and laying of tar paving deserves much more attention than is generally bestowed on it.

In no case should gas tar be used until the same has been stored for about six months, so that the volatile oils and whatever water may have been in the tar has had time to escape or come to the surface.

The tar should be drawn from the bottom of a covered tank at least 10 feet deep. If such stored tar cannot be obtained, refined tar (not pitch and heavy oils) should be used.

Coke Breeze in Tar Paving.—The Author in 1894 discovered coke breeze to the amount of 12 per cent. in a consignment of tarred topping that was intended to be used in the Wimbledon district,

and he has since found that several manufacturers add coke breeze to the aggregate used in making tar paving, on the assumption that it absorbs the volatile oils and causes the paving to set. It is needless to say that soft material such as coke breeze must materially reduce the life of the paving, especially when added in such a proportion as that mentioned.

Means of Detecting Coke Breeze.—It is impossible to detect coke breeze in tarred topping unless the tar is removed, which may be done by repeated boiling in water to which a large quantity of soda or potash has been added. By this means the stone used in the manufacture is cleansed, and its nature can be easily determined.

Heating of Materials.—This test affords, in the case of tar paving not more than four months old, a means of determining whether or not the stone was raised to a sufficient heat to thoroughly absorb the tar. If such heat was not sufficient, the tar can be easily removed from the stone, which it leaves perfectly clean; whereas, had the stone been raised to a sufficient heat, the tar would have been so thoroughly absorbed that it would be difficult to remove, and even after repeated washings the stone presents a dull, dirty appearance.

In manufacturing tar paving the common practice is to heat the stone proposed to be used in a heap or clamp, the clamp being fired at the bottom and coke breeze or small coal being mixed with the stone; when the fire is exhausted the clamp is allowed to remain for a day or so while it cools, and the heat gets more uniformly distributed. By this means it is impossible to uniformly heat all the stone to the required temperature.

Mr. E. P. Hooley, Mem. Inst. C.E., county surveyor of Nottingham, has adopted a circular clamp formed in four divisions, which can be fired consecutively, so that the stone may be drawn from one section whilst the others are still alight.

The best method the Author has seen for heating stone is on a hot hearth, on which the stone can be raised to such a temperature that it will absorb as much tar as possible without ignition. By this method there is no liability of coke, ashes or other foreign substances being unintentionally mixed with the stone.

Hot tar is added to the heated stone, and the same turned over with hot shovels until all parts of the stone are well coated. Many manufacturers add a small quantity of pitch (about 1 per cent.) to the caldron in which the tar is boiled.

Storage of Tar Paving.—Tar paving thus made should be stored for at least three months before being used. Most manufacturers are in the habit of freshening their paving with a little refined tar before the material leaves the works.

In storing tar paving it should be kept as free as possible from all damp. Tar paving improves if kept for at least two years, although the nature of the tar to all appearances has disappeared.

Size of Stone.—The size of the stone used should be fairly uniform ; thus the stone for the bottom, or as it is termed," bottoming," should not exceed 1 inch in diameter, and all the stone used should be retained on a sieve of $\frac{5}{8}$-inch mesh. In the case of the material for the top layer, or as it is termed, " topping," the material should pass through a sieve having $\frac{3}{8}$-inch mesh, and be retained on a sieve of $\frac{1}{8}$-inch mesh.

Derbyshire spar and Kentish rag produces the best tar paving that the Author has used, but he is of opinion that it would be advantageous to use a harder substance for topping.

Foundations and Laying of Paving.—In laying foot pavings, the Author has the foundation as already described formed to the same slope as the finished path. This is well rolled and then receives sufficient bottoming to form a layer 2 inches in thickness after rolling. The bottoming is rolled with a light roller, say not exceeding 5 cwt. for a width of 2 feet 6 inches. It may afterwards be finished with a slightly heavier roller. It is well that the bottoming should be subjected to traffic for a week or so before receiving the finished coat of topping, which should be carefully spread in a layer of sufficient thickness to produce 1 inch after rolling. The topping is first rolled with a light roller, and is finished with a double water-ballasted roller, 2 feet 3 inches wide over all and weighing 12 cwt. A little white spar is generally thrown on the surface and rolled in for the sake of appearance ; the surface being afterwards sanded to prevent the tar adhering to the feet of people walking over it.

Tar-Paved Crossings.—For carriage crossings the " bottoming " is laid in 3 inches thick, covered with an inch of topping as previously described.

The process of repairing tar-paved paths by covering them with a coat of topping is a most risky operation, for if wet weather sets in the rain soaks through the new topping, and as the old path is impervious the topping becomes saturated with water, which when walked over works into a buttery mass, and mud and dirt get intermixed in some cases to such an extent that the topping will

not adhere. Only well seasoned topping should be used for coating old paths.

Dressing.—Tarring and sanding, or as it is termed, "dressing," the surface of tar paths should be done during dry weather, the first summer after the tar paving is laid and afterwards triennially. The tar used for this purpose should be well seasoned or refined tar, heated in a caldron with a little pitch. After the surface of the path is swept clean and the hot tar well rubbed in, a layer of dry sharp sand about $\frac{3}{16}$ inch thick is spread on the tar so as to keep it from adhering to pedestrians' feet. As this sand gets forced into the tar by people walking over the path, it forms as it were a thin coating, which preserves the life of the path considerably.

Asphalt Paving.—Proper asphalt forms on level ground a good paving for footways. Unfortunately, on account of what is technically termed "creeping," it cannot be laid on paths having a considerable inclination, or cracks occur which increase.

Asphalt should be laid on a foundation of about 3 inches of concrete, the thickness of asphalt being about $\frac{3}{4}$ inch. Unfortunately this paving cannot be repaired with a top layer as is done in the case of tar paving, when trenches have to be cut through the pavement. Indications are left after the same has been repaired.

Only a small amount of asphalt has been laid in the Author's district; its life has not been found to compare favourably with that of concrete slab pavings, as will be seen from Table A, p. 312.

DISCUSSION.

Mr. J. T. Eayrs: With regard to the paper, there is only one branch of it I wish to make a few remarks upon, that is, the question of blue Staffordshire brick paving. It is a subject I ought to know something about, as well as my friend Mr. Lobley. I have had twenty years' experience of blue brick paving in Staffordshire, and coming from a town where they make a great many of them, I venture to think I know something of this subject. I take exception to the remarks of Mr. Cooper in his paper with regard to blue bricks. No doubt there are defects in this kind of paving as well as in other descriptions, but there are certain advantages attached to the use of blue bricks. The defects, as stated by the Author of the paper, are two. Mr. Cooper says "there are two

serious defects in blue bricks, viz. (*a*) the surface is so vitrified as to be slippery; (*b*) as a rule, the bricks are not burnt throughout, so that when the exterior blue coating is burnt through, the red central core of the brick offers little resistance to wear." Now I take exception to both those statements. In the first place I do not consider the paving to be slippery. I have laid between fifty and sixty miles of footpaths of this material, and I have never seen any one fall on them. A mistake some surveyors make is in laying chequered bricks. They think if they lay chequered bricks they give a better foothold to passengers. I do not think that is borne out by experience. In winter time, when snow is on the ground, the interstices get filled up with frozen snow, making it a more dangerous footpath. Besides, they cannot be so well cleansed. With regard to the second objection which has been taken, as to the burning of the bricks, the Author thinks if bricks are not burnt blue throughout they are not good bricks. I differ entirely from that statement. It is a mistake altogether to have bricks which are burnt blue throughout. The reason is this: it is quite impossible to burn a brick blue throughout without burning all the nature out of the clay. A brick burnt to this extent is liable to fracture and is altogether unfit for use. I should reject a brick which is burnt blue throughout. A paving brick to be of good quality should be blue to a depth of a quarter to half an inch from the surface, and the centre red. This burning makes a brick tough, and it will wear as long again as a brick which is burnt more. The disadvantage of this paving is that the colour is not cheerful: but I do not see how that disadvantage is to be got over. It is an exceedingly good paving for manufacturing districts, where the traffic is hard and the wear is heavy. As regards the advantages, I think they are more than the disadvantages. The chief advantages are that you get a good paving which is practically impervious; it is one which is easily cleaned; it soon dries after rain; it lasts a very long time; it is cheaper than most; and it compares very favourably with other kinds of paving. As to the breaking up of footpaths for repairs, I do not think there is anything easier to take up and repair than blue bricks. We all know if a concrete pavement has to be cut up for laying pipes and other things, the appearance after repairs is a regular patchwork.

A Member: What size of brick do you use?

Mr. Eayrs: You can have the bricks made any size. The standard size I adopt is ten by five inches, which is a convenient

size for laying. In the statistical part of the paper, on p. 312, the life of blue bricks is given as twelve years. Well, I know pavements which have been laid thirty years, and they are as good to-day as when they were laid. In confirmation of this, I would say the Local Government Board will grant a twenty years' loan for blue brick paving. If twelve years is the life of the pavement, I am sure the Local Government Board would not grant a loan for twenty years. It is much more likely to last thirty years than twelve years if they will grant you a twenty years' loan.

Mr. E. J. Silcock: Another pavement which is not touched upon in the paper is the class of flags we saw at the Brighton works yesterday—home-made flags. The large bulk of the flags required in most towns are for second-class streets, and we want some material for such footpaths which is good but cheaper than Victoria stone or other similar flagging. These materials make splendid footpaths where there is very heavy traffic, but they are too expensive for many streets. I have placed on the table two samples of home-made flags; one is a piece of a new flag, and the other is a piece which has been down for seven years under fairly heavy traffic, and shows a very good surface now. These flags are made $2\frac{1}{2}$ inches thick, the lower inch and three-quarters of three parts of beach shingle, one part of sand, and one part of cement; and the top three-quarters of an inch, of granite chippings with the sand left in, and cement in equal proportions. The flags are made on a concrete floor with wood screeds faced with iron. The floor is sanded over with dry sand and the screeds are greased to prevent sticking. The surface of flag is on the top, and after being floated and trowelled to a fair face, a roller with ribs on it is passed over the flag, giving it a grooved surface, the grooves running the long way of the flag, i.e. across the foopath. We can make that flag for 2*s.* 7*d.* a square yard. We can put a similar concrete down *in situ* for 2*s.* 6*d.* a square yard without foundation. I find in practice the flags do not crack any more than Victoria stone. I had some pieces of flagging measured up, and they compare very favourably as to the ratio of square yards per crack with Victoria stone and Stuart's granolithic and Imperial stone as given by the Author, whose results are better than usual. As we get these results for about half the price of these stone flags, I do not think one would wish to give up the manufacture of home-made flags.

Mr. W. H. Savage: I can bear out what Mr. Eayrs has said

as to Staffordshire blue brick paving. The first pavement laid in my district was blue Staffordshire brick, and it is in very good order though it has been down twenty years. The bricks are of plain surface, and though they do not retain the blue colour altogether the paving is a very good and sound one now. I have recently laid a considerable quantity of cement *in situ*.

Mr. A. E. Collins, Norwich: I object to the principle of making up private streets before the houses are erected. It simply means that whatever care is taken by the local authority and its officials, the kerbs and channels get knocked about, and the builders cannot help breaking up the streets for gas and water mains. It seem to me to be wrong to insist upon the making up of streets until the houses are fairly well built up. I do not think it is right to wait until every house is built up. You must settle each case in accordance with the actual facts. I should like to ask whether the brindled bricks would be as good as the blue bricks and somewhat cheaper.

Mr. MacBrair: I do not quite understand what Mr. Eayrs said about the colour of the bricks. Manufacturers who have spoken to me have claimed superiority for their bricks because the blue colour was uniform throughout. They said if a brick was red inside it was due to inferior clay being used.

M. J. Lobley: I can corroborate what Mr. Eayrs has said as to blue bricks. So far as Staffordshire bricks are concerned, it would be a mistake for the brick to be blue all through, for if it is, it is over-fired. Blue bricks make a good footpath, and in Staffordshire at one-third the cost of flagging; but when you get so far away as East Ham I am surprised to hear that they have been used there, where of course the relative cost is very different. They are a rather slippery pavement, and as to chequred bricks I cannot quite support Mr. Eayr's opinion. Where a gradient exceeding 1 in 25 exists it is necessary they should be chequered in some way. Certainly a diamond chequer with little or no groove is no good; but circular discs not too close together are of very considerable benefit in affording a foothold. A good pavement will certainly last more than twenty years. I have a good many miles of footpath which have lasted over twenty years and are still in a good state. With regard to Mr. Collins' question as to brindled bricks, I may say they are almost as good as blue bricks, and personally I like the colour better. Another advantage is a great one, in the ease with which they can be taken up and relaid

as compared with concrete or Val de Travers pavement. This has been particularly useful during the laying of the electric light mains.

Mr. W. H. White: To add anything in praise of blue bricks after the objections to them having been so well disposed of by previous speakers, seems almost like killing the slain. I may say, however, that I have read the opinions of the Author of this paper almost with amazement. I have used blue bricks for something like twenty-five years pretty constantly, and there are bricks laid in the city I represent, which were down some years before I went there. These still retain their colour and present a very fair surface. I cannot say I have found them slippery; certainly they are not so slippery as artificial paving, and very little more slippery than York paving. I dissent from what Mr. Eayrs has said as to the use of the bricks with a pattern on, as I have found them preferable to plain ones. In a few cases where smooth bricks have been laid they are a little slippery. The comparison which is made in the paper between the wear of blue Staffordshire bricks and the so-called imperishable granite vitrified paving bricks surprises me. It is true I have not had a long experience of the latter material. I have, however, had seven or eight years' experience, and my verdict would be quite contrary to the opinion expressed in the paper. I have not found them wear well. Some laid in 1888 are at the present time in holes. I must express my strong opinion that the average life of good blue bricks is certainly twenty years and probably more.

Mr. T. W. Stainthorpe: I can bear out the remarks of Mr. Eayrs as to the life of Staffordshire bricks. Previous to the introduction of composite flags, blue bricks were extensively used in my district. But for the last fourteen or fifteen years, on the banks of the Tees we have obtained a splendid composite flag made from slag which is iron manufacturers' refuse mixed with cement. We got an excellent flag from these materials for 2*s.* 6*d.* a superficial yard. I have laid thousands of yards of these flags, some of which has been down for twelve years, and we have no difficulty in getting a loan sanctioned for these footpaths for twenty years. They form a splendid footpath, and are much cheaper than natural Yorkshire flags.

Mr. C. H. Lowe: I think it is much to be regretted that the Author is unable to be present to hear and to reply to the discussion, as the paper teems with debatable matter. I quite agree with

Mr. Collins as to the making of new streets. It is well known that if you make up a street too soon you cannot keep it in good order, as it must be cut up for gas and water pipes and other incidental purposes. I do not think that the Author is justified in saying that the owners of property are damaged by not having the roads made up before the houses are erected. With regard to the kerb, Mr. Cooper says unless the kerb is omitted for lamp posts the posts come too far into the path. We have experienced considerable difficulty with regard to this subject, and we are now obliged to put the lamp posts within the kerb line. I see the Author disposes very briefly of York paving. I like to stand up for old things when they are good, and I have some York paving which has seen fifty years' wear in my parish and which is still doing public service. It is all very well to advocate concrete paving, but still there are some good qualities about York paving which cannot be passed over. With regard to Stuart's granolithic, Mr. Robson, of Willesden, has laid down a large quantity in his district, but I think he is beginning to find it is not the great success which he anticipated. When once you cut a trench through this pavement it is very much damaged, although it is very nice and handsome when first laid.

Mr. S. Stead: I should like to emphasise what Mr. Cooper says on p. 318 with respect to tar paving. He says "the manufacture and laying of tar paving deserves much more attention than is usually bestowed on it." I quite agree with the Author of the paper there. Perhaps one of the reasons why some surveyors may have tried tar paving and found it not altogether a success, is the method adopted of heating and mixing the materials. The usual or common method of making is to heat the material on the ground. If it is heated, as Mr. Cooper suggests, by putting the stone on hot plates, on which it is raised to such a temperature that it will absorb the tar, and is turned over with shovels until all parts of the stone are thoroughly coated with tar, it answers very well indeed. For the information of some surveyors here who may not have tried it, I may say I have had a kiln formed in this way—something after the manner in which bricks are dried—in which the material is heated over iron plates, and I find it answers very well indeed. It has this very great advantage, that the stone can never become over-burnt. You can turn it over and over, and so thoroughly mix it with the tar that it makes an excellent material for footways and roadways.

Mr. W. Jones: On p. 312 Mr. Cooper gives the price of

tar paving as 2*s.* 6*d.* per yard super. In Colwyn Bay, in the limestone district, we managed to lay tar paving for 1*s.* 3*d.* per yard super. We have laid something like 15,000 yards of tar paving at that price.

Mr. W. Nisbet Blair: The number of slabs cracked in the table on p. 311 (Table C) is abnormally small. I am sure if I had been able to count up the breakages in several streets where we have some of these patent stones laid, I should have found a very much larger number of cracked stones in the paving laid. I have observed a road in Brighton, coming down from the station, where I should think 30 per cent. of the slabs are cracked across, but perhaps the President can give us particulars about the proportion of broken slabs in that case.

The President: I am very sorry Mr. Cooper is not here, as the paper is full of debatable matter. I, having had experience of every kind of material mentioned in the paper, should have been glad if we had had more time at our disposal, and the Author here, so that we could have gone more closely into the matter than we have been able to do. With reference to blue Staffordshire bricks, in my early days I had occasion to use a very large quantity of blue bricks, and more or less I have used them during the whole of my career in suitable places. I had the opportunity a few weeks ago of walking over some of the blue brick paving laid by myself over twenty years ago, that had been subjected to very considerable wear indeed, and I was quite astonished and pleased at the small amount of wear shown at the present day; proving to my own satisfaction what has been said by other speakers this morning, that the life of Staffordshire blue brick is more than twenty years. With reference to concrete slabs and other concrete pavings, those members who went to Hollingdean depôt yesterday had an opportunity of seeing the slabs we manufacture there. The manufacture of slabs and the laying of pavement *in situ* has been carried on for some years in Brighton, and considerably extended during the last seven years. It may be said we manufacture the whole of our paving either *in situ* or slabs. Mr. Blair mentioned a road where a considerable number of the slabs are broken. I can take Mr. Blair into many other streets in the town where the same thing occurs. I think it is some of the first paving that was laid. The system of laying the paving at that time was to lay it immediately on the chalk bed. On Friday I spoke of the damage that was done to our roads by the frost getting through the crowns of the roads,

and then when the thaw came the chalk swelled and broke up the entire surface of the road. The same thing has occurred where all these earlier pavements were laid, and so now we have adopted another plan. In frosty weather some of these early pavements have been lifted two or three inches, and then their backs have been broken in settling down again. Our practice now is to excavate some of the chalk and put in a foundation of rough rubble concrete or clinkers 2½ inches in thickness before we lay our cement paving on the top. That has been my practice now for five years and it has been a success. When I first came I noticed the difficulties, and I started this as a remedy. If you go over the pavements which have been laid since, I think you will find them very good. I claim we can make pavement in Brighton quite equal to Stuart's or any other firm. If you walk through the streets at the present time, you will see that nearly all the pavement has been laid by ourselves, excepting on the King's Road, where we have laid some Stuart's patent granolithic; and North Street, where we have laid a certain portion with patent Adamant slabs. At the time this street was relaid we had not sufficient of our own material in stock, and we purchased some Adamant to give it a trial. It has been down three years and appears to be quite satisfactory, but as it has been laid so recently I am not in a position to give you any more positive information respecting it. I see nothing in its condition, although it is a pressed stone, to lead me to believe it is going to wear better than our own manufacture, but time will prove it. It is too early at present to say anything more definite about it. The cost of our own slabs is 4*s.* per square yard at the works. All the granite we get costs us about 12*s.* per cubic yard, which therefore makes the manufactured article more expensive than if beach or other cheaper material were used. That we lay *in situ* costs us about 4*s.* per square yard laid complete. I have adopted the plan of colouring the cement used for the top dressing of the pavements, and it is found to be much more pleasant than a plain white surface, which is very trying to the eyes in the glare of the summer sun. I have used also with good effect in some places Candy's vitrified chequered paving bricks, which have proved to be very hard and durable. I have also used a great deal of Patent Victoria stone, Imperial stone. On these and many other points I should like to speak, but time will not permit.

A vote of thanks to Mr. Cooper for his paper was proposed by Mr. W. Nisbet Blair, seconded by Mr. Collins, and carried.

The visits to public works were of unusual interest and importance. On Friday, immediately after luncheon, which was provided by the President in the Royal Pavilion, the Members drove to the Central Electric Light Station in North Street. The electric installation is one of the largest and most complete in the country, and considerable extensions are being carried out to keep pace with the increasing consumption of the light. The whole of the buildings have been designed by the President of the Association, and the electricity works are under the control of Mr. Wright, Borough Electrical Engineer. The works are very fully described in the paper read by Mr. Wright at the District Meeting of the Association held at Brighton in 1895. *From the Electric Light Station the Members drove to the Hollingdean Road Depôt, where opportunity was given to watch the process of the manufacture of the artificial paving slabs which are extensively used for the footpaths of Brighton. The extensive and admirably arranged abattoir, erected by the Corporation, and the dust destructor were also inspected. By way of Preston Park the Members drove to the Water-works Pumping Stations at Patcham and at Goldstone. The works are fully described in the paper read by Mr. Johnstone, water-works engineer, at the District Meeting at Brighton in May* 1895.

At the conclusion of the discussions of the papers on Saturday, a further round of visits was paid to the extensive public works which are being carried out at the sea front. The new sea walls and groynes near the West Pier, the works at Black Rock, the Paston Groyne Station of the Volk submarine railway to Rottingdean, and the sewer ventilating furnace at Roedean. The sea works are of the very greatest importance to Brighton in preventing the encroachment of the sea. Beside the construction of the sea wall, the old groynes are being heightened and extended, and a new groyne, running seawards for about 150 *feet, is being constructed. As a result of these works, a very large area is being reclaimed for promenade purposes. On returning to the Pavilion, the Members were entertained to luncheon by Mr. T. Wilkinson, of Messrs. B. Cooke and Co.*

APPENDIX.

PAGE

DESCRIPTION OF PUBLIC WORKS VISITED AT BRIGHTON DURING THE ANNUAL MEETING, JUNE 25, 26 and 27, 1896 .. 332

LIST OF BOOKS OF STATISTICS AT OFFICES OF THE ASSOCIATION 342

EXAMINATIONS 347

BOARD OF EXAMINERS 357

CERTIFICATED CANDIDATES 358

MEMOIRS OF DECEASED MEMBERS 363

DESCRIPTION OF PUBLIC WORKS VISITED AT BRIGHTON

During the Annual Meeting, June 25, 26 and 27.

By FRANCIS J. C. MAY, M. Inst. C.E.

As I was unable to devote much time to the explanation of the details of the various works visited by the Members of the Association at the Annual Meeting held at Brighton on June 25, 26 and 27 last, I promised to give a brief description thereof in a paper to be added as an Appendix to the Annual Volume of 'Proceedings.' I therefore offer the following brief particulars in redemption of that promise.

The New Valley Sewers.

The "separate" system of sewers has not been adopted at Brighton. The sewers receive both the sewage and surface water. The natural drainage of the largest area of the site of the town is the Steine Valley, i.e. from the Old Steine to St. Peter's Church going northwards, where it branches off in two directions: Richmond Place and Lewes Road forming the eastern valley; London Road and Preston Road the western valley. The land lying between these two valleys rises from each, forming a hog's back, and it naturally drains back to them. On either side of these valleys the land rises very rapidly to a height of more than 200 feet, forming very steep gradients in the streets, many as much as 1 in 20, 1 in 12 and some 1 in 6. It will therefore be readily understood that in wet weather the valley sewers soon become full, and especially in the case of heavy rainfalls and sudden storms. Owing to the great growth of the town the valley sewers, which were originally well designed as regards capacity, have lately been proved to be too small. The Author therefore recommended that an auxiliary sewer should be laid in the Steine valley, and that the sewer in London Road and Preston Road (the western valley) should be reconstructed and considerably enlarged. This was a work of considerable difficulty. The old sewer is circular, 8 feet in diameter. The new auxiliary sewer was laid from the overflow chamber in Old Steine enclosure to Trafalgar Street, a distance of 2578 feet. It is constructed in a line parallel to the old sewer, but at a sufficient distance therefrom to render the excavations safe. It is also a circular sewer 8 feet in diameter. It

is built of two rings of brickwork in cement. The gradient is 1 in 131. There are six large bell-mouthed junctions constructed to form the connections with branch sewers from the side streets. The whole of this work was constructed in tunnel, to avoid hindrance to traffic or business. There were only five open shafts in a distance of nearly 3000 feet. The excavation was wholly in chalk or in coombe rock (a local term for the alluvial deposit washed down from the chalk hills into the valleys in the early days of the earth's history). The average depth of the tunnel was 19 feet. After the headings were driven and timbered, the sewer was built in eight-feet lengths; the invert was first built up to the springing; the centres were then fixed and the crown built; the space between the haunches and crown of the brickwork and the top of the heading was filled in solid with lime concrete gauged 6 to 1. When the work was sufficiently set, the centres were struck, the inside of the brickwork was cleaned off, and the joints raked and pointed with neat cement.

There were of course many unforeseen difficulties to be dealt with, and the line of the sewer had to be frequently varied, or curved, to overcome these obstacles. This rendered the work of ranging the lines, curves or reverse curves, and of keeping a true level throughout, a very difficult operation. Nevertheless when the lines, curves and levels were tested at completion, it was clearly ascertained that absolute truth and accuracy had been maintained throughout.

At Trafalgar Street the western valley sewer was disconnected from the old main valley sewer, and attached to the new main valley sewer. Thus the old main valley sewer now receives only the streets lying east of it, and the eastern valley sewer. The new main valley sewer takes all the sewers lying west of it, and the western valley sewer. This practically divides the borough into two nearly equal drainage areas, each having its own main valley sewer. Both these main valley sewers discharge into the large overflow chamber in the southern Steine enclosure.

Going northward from Trafalgar Street the eastern valley sewer remains untouched, but some portions of the western valley sewer were enlarged.

The western valley sewer in London Road, near Trafalgar Street (its junction with the new sewer), is an oval sewer 7 feet 6 inches by 5 feet as far as new England Road, a distance of 2350 feet, and was not altered. From this point the sewer in Preston Road (constructed in 1875) is oval, 5 feet 6 inches by 2 feet 6 inches. Since it was constructed an area of land 206 square acres in extent has been built over, and now comprises 17 miles of streets. It was therefore found desirable, from New England Road to Stanford Avenue, a distance of 1350 feet, to replace the old sewer by a new one 7 feet 6 inches by 5 feet, oval. Seven bell-mouth junctions were

constructed on this line, and a special double one 30 feet long, at New England Road, to receive other sewers. The new sewer was laid in an open cutting on the site of the old one, at a depth of 15 feet, and therefore special provision had to be made during its construction for the flow of sewage from the northen part of the valley. The invert of this sewer was made of concrete blocks cast in one piece, 1 foot long and 3 feet 3 inches wide. The concrete was gauged 3 to 1. The rest of the sewer was constructed of two rings of brickwork in cement, as before described, and the trench was filled level with lime concrete to a height of 6 inches above the top of the sewer.

In addition to the before-mentioned works, it was also found necessary to improve the drainage of a portion of the Montpelier district in the western part of the borough, and to form a new storm-water sewer opposite the Norfolk Hotel to relieve the intercepting sewer, also at the west overflow of the borough. The former was effected by laying an auxiliary sewer in Montpelier Terrace, from a point near Arnold House to a point in Montpelier Road near Christ Church, where a junction was made with the existing sewer. The new sewer was made of 12-inch stoneware pipes, laid in open cutting at an average depth of 15 feet, jointed with cement. The latter was constructed in connection with a new groyne at the point named, which will be described hereafter.

This completes the description of the work in connection with the valley sewers. They discharge into a new large overflow chamber constructed in the South Steine enclosure. This chamber is 90 feet long, 23 feet wide, with a circular roof 17 feet high. It is built with four rings of brickwork in cement. It has an overflow sill or weir, which crosses the chamber diagonally throughout its entire length. The level of the sill is about 18 inches above high water-mark at ordinary spring tides. The two valley sewers, each 8 feet in diameter, enter the chamber at the northern end, and under ordinary conditions flow direct into the intercepting sewer of the Brighton Intercepting and Outfall Sewers Board, which is laid parallel with the seashore; but in times of heavy rainfall the water rises and flows over the weir in the chamber into the two (old and new) storm-water overflow sewers, each 8 feet in diameter. These overflow sewers pass beneath the intercepting sewer, and discharge into another, but smaller, new overflow chamber constructed under the road between the Aquarium and the Albion Hotel, with an outfall into the sea to relieve the Intercepting sewer in times of flood. The new overflow sewer, 473 feet in length, is built of three rings of brickwork, and the trench filled with concrete as before described. It was all constructed in tunnel at an average depth of 27 feet. The overflow chamber is 24 feet long, 13 feet wide, with a circular roof 13 feet high. The weir extends the whole length of the chamber, and is 18 inches above high-water mark at ordinary

spring tides. It is constructed of brickwork as before described. The outlet sewer is oval, 10 feet 4 inches by 8 feet, and is connected with the new storm-water outfall sewer formed in the Albion groyne (hereinafter described), by which the flood water is discharged into the sea.

The cost of the before-mentioned works was 21,477*l.*

Storm-Water Outfall Sewer, Albion Groyne.

This is built to relieve the main valley sewers and the intercepting sewer in times of flood, by giving them an outlet direct into the sea. The existing groyne was widened to 30 feet, and was thus utilised for the formation of this sewer, which was built in the centre of it. The groyne extends 335 feet from the esplanade wall into the sea, and forms a handsome and favourite promenade. The method of its construction is the same as will be hereafter described in the formation of the sea defence works. The outfall sewer is oval, 10 feet 4 inches by 8 feet, and discharges into the sea at the south end of the groyne at the level of low water. It is built of concrete blocks 12 inches thick, gauged 4 to 1, cast to the proper shapes for the sides, top and invert. All the blocks are bedded in neat cement.

The cost of the work was 6500*l.*

Storm-Water Outfall Sewer, Norfolk Groyne.

A new groyne has been built opposite the Norfolk Hotel, near the west end of the borough, to facilitate the construction of a storm-water outfall sewer therein, to relieve the western section of the intercepting sewer in times of flood. This overflow and outfall sewer was formed exactly like that at the Albion groyne, and therefore no further description is needed, except that it is only 210 feet long and 7 feet 6 inches by 5 feet in size, and has an overflow chamber 40 feet long and 11 feet wide, with a sill running the whole length and 18 inches above high-water mark; the overflow passing by means of the outfall sewer direct into the sea.

The cost of this work was 5900*l.*

Sea Wall and Groynes, Western Foreshore.

The new sea wall extends from the western boundary of the borough to Regency Square groyne, east of the West Pier. It is 1632 feet long, and parallel to the esplanade wall. It will form a lower esplanade 100 feet wide, and will reclaim about 2 acres of beach from the sea. The foundations of the wall are carried down 18 inches into the solid

chalk rocks. The height is 25 feet at the east end, and 28 feet at the west end. The coping is an average of 12 feet above high-water mark. It is 9 feet thick at the base and 2 feet thick at the top. The face is built to a batter of 1 in 4, and near the top it is curved outwards with a parabolic curve, in order to reflect the waves in time of gales. There are counterforts at the back at intervals of 25 feet, the same height as the wall, each 4 feet wide by 4 feet thick. Access to the beach is provided at suitable places for pedestrians, by means of granite steps, and for bathing machines and boats by means of inclines, or gaps, as they are locally named. The face of the wall is built of flint-faced blocks, the stretchers 3 feet by 18 inches by 18 inches, the headers 2 feet by 18 inches by 18 inches. The backing blocks are the same size, but ordinary concrete blocks gauged 6 to 1. The facing blocks are cast in moulds, the face upwards, and are formed of large flints bedded by hand in Portland cement, one part to two parts compo sand. The outer joints are afterwards raked out and pointed with neat cement and cut. The blocks are set in neat cement, and bonded together as in masonry.

Norfolk Groyne.

This groyne has been already mentioned in connection with the description of the storm-water outfall sewer constructed within it. The method of construction is the same as that described for the sea wall. When completed it will form a handsome promenade groyne, similar to that already described as the Albion groyne. It will be 350 feet long and 10 feet wide, with steps at the south end to form a landing stage for boats.

Preston Street Groyne.

This groyne will be 352 feet long from the face of the new sea wall, and of the same height at the north end. This is not a promenade groyne, but is finished with a rounded top only 4 feet wide. It has a slope on the top of 1 in 40 for 100 feet, and then it has a gradual slope down to the south end, which is only 3 feet above low-water mark. The base is 13 feet 6 inches at the north end, increasing to 16 feet 6 inches at the change of gradient, and reducing to 4 feet at the south end. The foundation is carried into the solid chalk, like the wall, down to 1 foot above low-water mark. Beyond this they are formed of concrete in sacks, laid and bonded as blocks. The facing blocks and hearting blocks are made as before described for the wall. The batter of the sides is 1 in 4.

Oriental Place Groyne, Regency Square Groyne, Grand Hotel Groyne.

These are three old groynes of the same type as the last. They were built in the year 1887, but were temporarily finished at half their intended height until the beach might increase and rise to that level. It has done so, and they are therefore now being completed as originally designed.

The cost of all these works of sea defence is estimated at 18,884*l.*

Sea Wall and Groynes at Black Rock, the Eastern Boundary of the Borough.

These works are constructed in precisely the same manner as has been described in the account of the Western Foreshore Works.

The purposes for which these works were designed are threefold: to form a defence for the cliffs from the sea; to retain all the beach forming the foreshore between Paston Place groyne and the borough boundary; and to form an extension of the undercliff drive, named Madeira Road, from Paston Place groyne, making a total length from the Aquarium of 1½ mile.

The sea wall is 150 feet from the base of the cliff. It is 300 feet long, and 25 feet 6 inches high above the level of the chalk. The coping will be about 12 feet 6 inches above high water. It is 8 feet 9 inches thick at the base, and 4 feet 6 inches at the top. The face has a batter of 1 in 6. There are counterforts 5 feet wide by 4 feet 6 inches thick at the back, at intervals of 25 feet. At the western end there is a flight of granite steps leading down to the beach. At this end there is also a promenade groyne 500 feet long, 18 feet wide at the base, and 10 feet 6 inches wide at the top. The promenade, reached by a flight of steps from the wall, will be level for a distance of 250 feet from the wall. The deck level will be 8 feet 6 inches above high-water mark. From this point to the south end the top is alternatively landings and steps of 12 feet spaces. The end is 2 feet above low-water mark.

At the east end of the wall there will be a smaller groyne of the ordinary type, 350 feet long. The area reclaimed from the sea by these works is 1¼ acre.

These works, situate at the eastern end of the present borough boundary, have been designed with a view of some day extending the undercliff drive from this point to Rottingdean, a further distance of 3½ miles, should an opportunity offer for so doing. The cost of these works is 14,400*l.*

New Public Abattoir.

The site of the abattoir (about 3 acres, enclosed by suitable walls and fences) is admirably adapted for its purpose. There are good approach roads from each quarter of the town; there is a railway siding running into it, by which cattle and all kinds of goods may be brought to or removed from the abattoir. The whole area is covered with an impermeable pavement.

The position and aspect of the buildings have been selected so that they may be the least affected by the rays of the sun, with a view to keep them as cool as possible.

The buildings are very substantially built in stock brickwork with red brick dressings. The roofs are covered with tiles, as being the material best calculated to keep the buildings cool.

They are lighted principally by a glazed section running the whole length of the roofs on the northern side.

The interior of the slaughter-houses and hanging-rooms is lined with white glazed bricks to a height of 7 feet; and the floors are laid with Stuart's patent granolithic pavement, specially prepared to prevent slipperiness. The ventilation is most ample, and the artificial light is electricity.

Both public and private slaughter-houses have been provided, as also have all the necessary offices, stores and conveniences.

They have been carefully planned so as to embrace every facility for carrying on the work of slaughter in the most merciful manner. All the most approved labour-saving appliances have been adopted in the interest of the trade. The comfort of the animals has been carefully observed; convenient feeding lairs are provided for those which will be kept a few days; the fasting lairs are near the slaughter-houses, but are so arranged that a living animal may not see one being slaughtered. As soon as the dressing of a carcass has been completed, the meat is removed from the slaughter-house into hanging-rooms opposite the slaughter-house, but entirely cut off from it, so that the meat may not be polluted by any of the smells of the slaughter-house. There are no drains within any building. Everything that is practicable has been done to ensure cleanliness.

The hoisting gear and all the machinery and fittings throughout, are those known as "Meiklejohn's Patent," and were supplied by Messrs. Alexander Mather & Son, Edinburgh.

A resident superintendent has been appointed, who, having a knowledge of animals and meat, will also act as animal and meat inspector.

A plan was prepared for the erection of buildings capable of accommodating the whole of the slaughtering trade of Brighton, but

as the Corporation does not possess compulsory powers to close the existing slaughter-houses, it has been thought undesirable to erect the whole of the buildings at once. A small section has therefore been erected as a beginning, at a cost of about 8000*l.*, and in such a manner as to permit of such extensions from time to time as the exigencies of the trade may demand, until the whole of the business of the trade shall be transacted there.

It is hoped that this section, which forms only a small beginning of a good sanitary and merciful measure, may ere long accomplish all the good expected of it, and extend to such a degree as to close all the existing slaughter-houses in the midst of the town, and render the completion of the whole range of buildings an absolute necessity. Brighton may then boast of possessing one of the best and most perfectly arranged abattoirs in the kingdom.

New Refuse Destructor.

The works are situated in the corporation depôt, Hollingdean Road, at the north part of the town, and in a rapidly rising residential district.

For the purposes of description the buildings may be regarded as standing approximately north and south, the chimney at the south-west corner. There are two entrances to the depôt, which are in Hollingdean Road on the north side—one east and the other west of the destructor buildings. The ground has a natural slope from west to east, so that it was unnecessary to construct a special inclined approach roadway to tipping floor, as is generally the case. Instead, the ground was levelled and a concrete retaining wall built on the west and south sides with a 9-inch brick wall at top on the west side. The works consist of substantial buildings built of grey stocks with red brick dressings, the main portion containing the furnace floor and the tipping floor. The tipping floor is approached by means of a road on the west side, the road having a fall towards the entrance of the building. When inside the building the refuse is tipped directly into movable trucks, of which there are twelve, one to each cell. These trucks and the feeding openings have been constructed in accordance with the patents of Messrs. Boulnois and Brodie, and with all the latest improvements. The trucks are divided into six compartments, with doors in bottom opening downwards, which are supported by a series of small wheels running on a central rail. Each truck runs along a pair of rails, and, with the feeding openings, is moved by means of a winch (one to every two trucks and openings) fixed on a platform level with the top of the tipping beams.

There are twelve cells or furnaces, built back to back on the "Fryer" principle, as improved by Messrs. Manlove, Alliott & Co.

The cells are fitted with movable clinkering bars to be worked by hand. From the furnace doors two chains lead to the back of the cell, to which is attached a screen, so that when the furnace door is opened this screen closes the entrance to the flue and consequently prevents an inrush of cold air into the flue. The gases pass from the main flue through two of Jones' fume cremators, which will be maintained at such a temperature as to be quite sufficient to destroy all noxious gases produced during the cremation of the refuse. From the cremators the gases pass through a multitubular boiler, or through a by-pass flue to the chimney. Before entering the chimney, however, the gases have to pass through two large screens with an inch mesh, which screens are movable and capable of being pulled up and cleaned from time to time. They are designed to prevent pieces of paper, &c., from entering the chimney. There is also a dust pit just in front of the screens. The boiler has been tested to a pressure of 120 lbs., but at present the working pressure will be 60 lbs. The steam will be used to drive a small horizontal high-pressure non-condensing engine of 8 horse-power nominal, which will work two mortar mills. The steam will also be utilised for driving the stone-breaking machinery and a small pump.

It will be noticed that every consideration has been given to anything that will conduce to the comfort and convenience of the men. On the north side is a mess-room, lavatory and urinal, and on the south-west side is a bath-room with two baths, by which means the men can go away in a state of cleanliness instead of carrying home any of the refuse—a decided advance from a sanitary point of view. There is an office and weigh-bridge on the upper road, just before entering the building for the tipping floor. Access from the upper to the lower level is obtained by means of an oak staircase on the west side. The furnace floors and the open space around the building are paved with Stuart's granolithic, while to the north of the mess-room the ground has been paved with granite setts, as has also the roadway leading from the weigh-bridge across the entrances to the tipping floors. This roadway is carried by means of brick arches with the spandrils filled with concrete.

The buildings are built of grey stocks with red brick dressings, and Portland stonework to the gables, bands and strings. There are two entrances to the furnace floors on the south side, the main flue going through the central opening into the building containing the cremators and boiler, and thence to the chimney shaft. To the destructor building there are six roof trusses. The rafters are of T-iron, the tie rods and queen rods of round iron, the braces of L-iron, and the struts are formed of two bars of flat iron bowed and kept apart by three distance pieces. There are also two longitudinal tie rods of

round iron. A lantern, with wooden louvres and wind braces of L-iron, runs the whole length of the roof, and there are four triangular dormers with wooden louvres. The building is well lighted; the window sashes are of iron and glazed with rolled plate glass. The trusses of the roof of the cremator building are similar to those of the destructor building, but smaller. It also has a lantern with wooden louvres. The wall of the north end of the destructor building is built with a battered face. The flue from the mess-room is connected to the main flue. The roofs to all the buildings are covered with plain red tiles laid on boarding. As the plans and sections are fully figured, it is not necessary to mention in detail the various dimensions.

The chimney shaft of the refuse destructor is 225 feet above the ground level, and stands on a bed of Portland cement concrete 7 feet deep, which rests on the chalk. For a height of 50 feet the base is square, and of an external diameter of 20 feet 6 inches. The internal diameter is 8 feet 9 inches. The bricks are laid in blue lias lime mortar for 175 feet, and above that in Portland cement mortar. At regular intervals hoop-iron bond, well tarred, sanded and lapped at joints, has been built into the walls. The fire-brick lining extends to a height of 75 feet, and consists of 9-inch fire-bricks bonded at intervals to the adjacent brickwork with fire-clay bonding bricks. An air space is left between the fire-brick lining and the internal brickwork of shaft. The whole of the facing bricks to the square base of shaft, together with the moulded courses, angle brackets, quoins, pediments, bands and strings, are Jennings' brown salt-glazed bricks. The bricks used for the battered face are Candy and Co.'s granite, acid-proof, vitreous, buff facing bricks. The remainder of the brickwork is of stock bricks. The cap is of cast iron, hollow, moulded and panelled, made in sixteen pieces, bolted together and filled with concrete. Galvanised wrought-iron climbing irons, placed 18 inches apart, extend from bottom to top of shaft. The set-offs are of Portland stone, while the panels in the four pediments are of terra-cotta, moulded and enriched and with the borough arms. A polished grey granite inscription tablet is let in on the west side of the square base. There are two lightning conductors of copper tape. Scaffolding was erected to build the shaft to a height of 75 feet, the remainder being built from the inside.

Messrs. J. Longley and Co., of Crawley, were the contractors for the buildings, chimney shaft and retaining and boundary walls, their tender being 8169*l*. Messrs. Manlove, Alliott & Co., of Nottingham, provided and fixed the cells, charging apparatus, cremators, boiler pump, engine and mortar mills, the amount of their tender being 6856*l*.

RETURNS, OR BOOKS OF STATISTICS

On the following subjects lie at the Offices of the Association, 11 Victoria Street, Westminster, S.W., and are open to the inspection of Members.

Drainage (House).

Information from 31 towns. Compiled by J. Atkinson, A.M. Inst. C.E., Stockport.

Horses (Cost of Keeping).

Information from 29 towns. Compiled by M. Petree, A.M. Inst. C.E., Grimsby.

Lighting (Electric).

Information from 38 towns. Compiled by J. W. Brown, A.M. Inst. C.E., West Hartlepool.

Information from 88 towns and 10 London vestries. Compiled by J. W. Cockrill, A.M. Inst. C.E., Great Yarmouth.

Information from 58 towns. Compiled by W. A. Davies, A.M. Inst. C.E., Aston Manor.

Lighting (Gas).

Information from various boroughs. Compiled by J. W. Bradley, A.M. Inst. C.E., Nelson.

Information from 38 districts as to undertakings in the hands of Local Authorities. Compiled by P. Ross, A.M. Inst. C.E., North Bierley.

Lighting (Public Street).

Information from 21 towns. Compiled by A. H. Campbell, A.M. Inst. C.E., Canterbury.

Information from 54 towns. Compiled by C. C. Smith, Dalton-in-Furness.

Pavements (Comparison of Life and Cost of Granite and Gritstone).

Information from 33 towns. Compiled by C. F. Wike, M. Inst. C.E., Sheffield.

PAVEMENTS (TAR MACADAM).

Information from 51 towns. Compiled by A. E. Collins, M. Inst. C.E., Norwich.

Information from 72 towns. Compiled by J. Hall, A.M. Inst. C.E., Cheltenham.

PRIVATE STREET IMPROVEMENTS (CONSTRUCTION OF WORKS OF).

Information from 49 towns. Compiled by W. J. Newton, A.M. Inst. C.E., Accrington.

REFUSE (COLLECTION OF).

Information from 89 towns. Compiled by J. Price, A.M. Inst. C.E., Toxteth Park.

REFUSE (DESTRUCTORS).

Information from 36 towns. Compiled by W. Brooke, A.M. Inst. C.E., Richmond.

REFUSE (DISPOSAL OF).

Information from 39 towns. Compiled by J. Price, A.M. Inst. C.E., Toxteth Park.

REFUSE (REMOVAL OF).

Information from 87 towns. Compiled by C. R. Fortune, Bath.

ROADS (MAINTENANCE OF MAIN IN NON-COUNTY BOROUGHS).

Information from 83 towns. Compiled by W. H. Smith, A.M. Inst. C.E., Carlisle.

ROADS (STEAM ROLLING OF).

Information from 42 towns. Compiled by A. W. Parry, A.M. Inst. C.E., Reading.

ROADS (WATERING OF).

Information from 65 towns. Compiled by W. Dawson, A.M. Inst. C.E., Leyton.

SEWAGE (DISPOSAL OF).

Information from 53 towns. Compiled by J. H. Cox, M. Inst. C.E., Bradford.

SEWAGE (PURIFICATION OF).

Information from 41 towns. Compiled by H. Richardson, A.M. Inst. C.E., Oldbury.

Sewers (Ventilation of).

Information from 81 towns. Compiled by J. T. Earnshaw, A.M. Inst. C.E., Ashton-under-Lyne.

Shone's Hydro-Pneumatic System (Working of).

Information from 20 towns. Compiled by E. Buckham, M. Inst. C.E., Ipswich.

Slaughter-Houses.

Information from 22 towns. Compiled by J. W. Cockrill, A.M. Inst. C.E., Great Yarmouth.

Tramways (Street).

Information from 48 towns. Compiled by J. E. Swindlehurst, A. M. Inst. C.E., Burton-on-Trent.

Water Supply (Diameters and Depths of Mains Frozen in 1895.

Information from 55 Towns. Compiled by E. Pritchard, M. Inst. C.E., Birmingham.

Water Supply (for Domestic and General Purposes.)

Information from 111 towns. Compiled by J. T. Eayrs, A. M. Inst. C.E., West Bromwich.

Special Reports and Pamphlets.

Bye-laws of the Audenshaw Local Board.

Description of the Sewage Disposal Works of the County Borough of Burnley. By F. S. Button.

Fever Hospital. Description of the Blackburn. By J. B. McCallum.

Filtration of Sewage. By Geo. W. Rafter.

Genesee River Storage Surveys. By Geo. W. Rafter.

Havre, Question d'Assainissement.

Means of Regulating Vehicular Traffic. City Surveyor, Sydney. 1891.

Measures for Restricting the Use and Waste of Water in force in Rochester, N.Y. By Geo. W. Rafter.

Report on Cable Tramways. Borough Surveyor, Bradford. 1890.

Report on Drainage. Frognall and Oak Hill Park, Hampstead. 1892.

Report on Lighting the City of Liverpool by Electricity. City Engineer, Liverpool. 1892.

Report on the Collection and Disposal of House Refuse. Surveyor to Urban District Council, Wimbledon. 1891.

Report on Town Refuse Destructors. By Borough Surveyor of Ipswich. 1896.

Report on Water Supply. By Director of Public Works, Hong Kong. 1896.

Reports, Specifications and other Particulars of the Blackburn Corporation Municipal Works. J. B. McCallum, Borough Engineer.

Report to the Sewage Disposal Committee. By City Surveyor of Carlisle. 1896.

Report upon the Disposal of Refuse, &c., in Cities of Melbourne and Adelaide. City Surveyor, Sydney. 1891.

Sewerage of Geneva. By Geo. W. Rafter.

Some Recent Advances in Water Analysis for the Detection of Sewage Contamination. By Geo. W. Rafter.

Specification, Wood Paving and Cube Sett Paving. City Surveyor, Sydney.

The Hydraulics of the Hemlock Lake Conduit of the Rochester Water Works. By Geo. W. Rafter.

The Meteorology of Nottingham. Also Chart showing the relation of the Number of Deaths from various causes to Meteorological Conditions for 1891–1895. Compiled by A. Brown, M. Inst. C.E., Borough Surveyor, Nottingham, and Philip Boobbyer, M.B.

Annual Reports.

Borough Surveyor of Stockport. 1891–92.

Borough Surveyor of Walsall. 1891–92.

Borough Surveyor of Wednesbury. 1894–95.

County Surveyor of Bedfordshire. 1894–95.

Director of Public Works, Hong Kong. 1895–96.

Municipal Engineer of Shanghai. 1894–95.

Metropolitan Board of Water Supply and Sewerage. Sydney. 1891.

State Engineer of New York. 1894–95.

Town Engineer of Johannesburg. 1894–95.

Vestry Surveyor of Kensington. 1894–95.

Borough Surveyor, Stockport, to the Highways and Sewers Committee. 1890–92.
City Surveyor, Montreal. 1890–91.
City Surveyor, Sydney. 1889–95.
Executive Board of Rochester for the years 1888, 1889 and 1890.
Surveyor to the Vestry of Fulham. 1890–91.
Surveyor to Urban District Council, Willesden. 1890–95.

VOLUNTARY EXAMINATIONS.

SYLLABUS.

The Incorporated Association of Municipal and County Engineers undertake the holding of Voluntary Pass Examinations for Candidates for Surveyorships under Municipal Corporations and the Local Government Acts.

There are two Examinations in each year, one in April, in London, and one in October, in some provincial town to be fixed on by the Council and advertised six months beforehand.

The Examinations are by written papers and *vivâ voce*, upon the four following subjects :—

1st. Engineering as applied to Municipal Work.
2nd. Building Construction and Materials.
3rd. Sanitary Science as applied to Towns and Buildings.
4th. Municipal and Local Government Law as relating to the Work of Municipal Engineers and Surveyors.

Candidates are allowed two hours to answer the questions under each of the four heads, and are not necessarily required to answer all the questions set in each paper, though not less than four must be taken : marks are given for all questions properly answered. The *vivâ voce* examination is held after the written papers have all been sent in, and is directed to the further elucidation of the answers to the papers on each subject, and to such practical points as fairly arise therefrom.

The Examinations extend over one or two days, as circumstances may require, and in the latter case the arrangements are, as far as possible, as follows:—

First day	..	10	to	12	..	Engineering.
,,	..	2	,,	4	..	Building Construction.
,,	..	5	,,	7	..	Sanitary Science.
Second day	..	9.30	,,	11.30	..	Municipal and Local Government Law.
,,	..	12	,,	4	..	*Vivâ voce* Examination.

The total number of marks required to constitute a pass is 50 per cent. in each of the subjects.

Each candidate has to fill a Form of Application, to be obtained from the Secretary.

Candidates must have attained their twenty-second birthday.

The fee for each Examination is 3*l.* 3*s.*, one guinea to be paid on application, and the balance on the day of examination. Should the candidate fail, he is entitled to present himself again at the next or any subsequent Examination, on payment of one-half of the above fee, one guinea to be paid on application and half a guinea on the day of Examination.

No further charge is made to the candidate than the fees above mentioned.

Candidates who do not present themselves for the Examination forfeit the entrance fee.

Successful candidates will receive a Certificate in the form of a "Testamur," signed by the Examiners for the time being, and countersigned by the President and Secretary of the Association in Council.

Further details and particulars may be obtained on application to Mr. Thomas Cole, Secretary to the Association, 11 Victoria Street, S.W.

SUBJECTS OF EXAMINATION.

I.—Engineering as applied to Municipal Work:

A. Land Surveying and Levelling.
B. Hydraulics.
C. Sewerage and Sewage Disposal Works.
D. Water Supply.
E. Road Making.

II.—Building Construction: Strength of Materials:

A. Materials.
B. The Construction of Public and Private Buildings.
C. Building Bye-laws.
D. Public Baths and Hospitals.

III.—Sanitary Science as applied to Towns and Buildings:

A. Ventilation of Buildings.
B. Scavenging and Disposal of Refuse.
C. House Drainage.
D. Disinfection.

IV.—Municipal and Local Government Law as Relating to the Work of Municipal Engineers and Surveyors.

Note.—The Examiners do not recommend any particular text-books, as it is desired to make the Examinations rather a test of the candidate's practical knowledge of the subjects generally, than to find his aquaintance with any particular book or books.

EXAMPLES OF QUESTIONS.

The following are the Examination Papers set to the candidates at the Twentieth Examination, held at the Town Hall, Manchester, on the 4th and 5th October, 1895, and serve as examples of questions proposed under the different sections.

Subject:—Engineering as applied to Municipal Work.

Examiner: T. De Courcy Meade, M. Inst. C.E.

1. Draw a transverse section, to an inch scale, of a street tramway for horse traction, with girder rails. Give a short description of same, specifying quality of metal, tests required, weight and depth of rail, the mode of jointing, and the foundation, &c.
2. Describe briefly each system of mechanical traction in use on street tramways in this country, and state the advantages or disadvantages of each.
3. One million gallons of sewage is to be pumped in 24 hours, consecutive working, total length of vertical suction 20 feet; height from centre of pump barrel to point of discharge 50 feet; length of rising main, with uniform gradient, 500 feet. State the power required, and describe the engines and pumps, valves, &c., you would recommend, giving the size of cylinders, length of stroke, &c., and the diameter, thickness of metal, and weight of rising main.
4. Make an outline sketch to scale of a steel girder bridge to carry ordinary urban street traffic, clear span 50 feet; width including footways 40 feet; depth from under side of girders to surface of carriageway 2 feet 6 inches. Give dimensions and weight of principal members and the safe distributed load.
5. A town with a population of 25,000 and an area of 2000 acres, soil stiff clay, rainfall 36 inches per annum, heaviest rainfall recorded per 24 hours 1¾ inches; 50 per cent. of storm water can be discharged into natural watercourses. Give the diameter and discharging capacity of the outfall sewer you would provide, the length being 2 miles, and the total available fall 2 feet 4 inches. Give also the necessary tank area (average depth of 6 feet) for chemical precipitation. State the depth, area, number, and particulars of construction of filters for the purification of the effluent, a first-class effluent being necessary: all manufacturers' refuse excluded from the sewers.
6. In electrical engineering, what is understood by the term "Watt"? Compare it with horse-power. What is meant by the term "ohm"? Define kinetic and potential energy.

SUBJECT :—BUILDING CONSTRUCTION, &c.

Examiner: Edward Pritchard, M. Inst. C.E., F.G.S.

1. Sketch and describe the best arrangements you would devise for supporting the front wall of a building, 30 feet high, during the re-building of adjoining premises. Also give an enlarged sketch of the needle and wedges.

2. What would guide you in the selection of the most suitable bricks for constructional purposes?

3. What are rich or fat limes? What are their uses; and what precautions must be taken in using them?

4. What proportion of sand should be used in making cement mortar and lime mortar, respectively, for use in the building of ordinary brickwork?

5. How would you prevent moisture from the ground rising up the walls of a building? Give a sketch.

6. Give sketches and descriptions of the following joints in stone :— Dowelled joint, joggled joint, grooved and tongued joint, metal cramp, and lead plug.

7. Explain the following :—Larrying, grouting, flat joints, struck joints, tuck pointing, and black pointing.

8. Give a sketch of each of the following bonds, used in brickwork :— English bond, English garden bond, Flemish bond, and Flemish garden bond.

9. Give sketches and sizes of scantlings in timber roofs of 20 feet, 40 feet, and 60 feet spans. What advantage has a queen post over a king post truss?

10. Give a sketch of a "scarf" to resist tension, and another to resist compression.

11. Describe the various slates, and sizes, used for covering roofs, and the manner in which they are secured.

12. Describe fully what is meant by the following terms used in plumbing work :—Valleys, gutters, and step flashing. Also state what weight of lead per square foot you would specify to be used in each case.

Subject :—Sanitary Science.

Examiner: James Lemon, M. Inst. C.E., F.R.I.B.A., F.S.I., &c.

Ventilation.

1. What cubic space would you allow per patient in a fever ward, per head in an ordinary sleeping apartment, and per head in a common lodging house?
2. How would you heat and ventilate the wards of a fever hospital; state how many times you would change the air per hour, and also what means you would adopt to insure such change in summer when heating is not required?
3. What proportion of area should inlets bear to outlets, and what velocity would you permit for inlets in order to prevent draughts, assuming that heating is not combined with the ventilation?

House Drainage.

4. Make sketch of drainage to a detached house, showing sizes and falls of drains; describe materials used, methods of laying and jointing, and connections from bath, lavatory, sinks, and w.c.'s ground and upper floor.
5. If you were called in to test the drainage and to report upon the sanitary condition of a house with the connections described in Question No. 4, how would you go about it?
6. Make sketch of section of four w.c.'s, one over the other, to four flats, and all connected to one soil pipe.

Sewage Disposal.

7. How would you dispose of the sewage of an inland Lancashire town of 10,000 inhabitants, and give details of proposed arrangements?
8. What number of tanks, and sizes thereof, would you employ for the precipitation of the sewage of 16,000 persons, the water supply being 25 gallons per head per diem; state whether used constantly or intermittently, if the latter, the time of rest.

Water Supply.

9. If a village be supplied with water from a well in a valley, and such water was thought to be impure, what steps would you take to ascertain the causes of contamination?
10. State the sanitary objections to an intermittent water supply.

SUBJECT:—PUBLIC HEALTH ACTS AND RIVERS POLLUTION ACTS.

Examiner:—John T. Eayrs, M. Inst. C.E., F.S.I., &c.

1. (*a*) What is a bye-law?

   (*b*) Name the subjects on which bye-laws may be made, and what proceedings are necessary before they are of any effect?

2. Under what circumstances can an owner of property be compelled to drain his premises into a public sewer, and state—

   (*a*) Mode of procedure.
   (*b*) Proceedings in default.

3. What are the conditions under which a person may cause his drains to empty into a public sewer? Can a local authority be compelled to make the communication at the cost of the owner; if so, under what Act, and under what conditions?

4. What person or persons have public statutory powers to alter or divert sewers belonging to a local authority, what are the conditions to be observed, and what is the duty of the surveyor?

5. Under what circumstances can a local authority supply gas and water in their district?

6. Under what conditions can a local authority compel a proper supply of water to be laid on to premises in—

   (*a*) Urban Districts,
   (*b*) Rural Districts,

   and state the mode of procedure in each case?

7. Name the parts into which the Public Health Act Amendment Act, 1890, is divided; what steps must a local authority take to adopt the Act; and can any part be adopted?

8. Define "Factory" under the Factory and Workshop Act, 1891, and what are the duties of the surveyor under the Act?

9. (*a*) What Acts have been passed for the prevention of pollution of rivers?

   (*b*) State briefly the provisions contained therein.

   (*c*) Define "pollution."

EXAMPLES OF QUESTIONS.

The following are the Examination Papers set to the candidates at the Twenty-first Examination, held at the Institution of Civil Engineers, London, on the 10th and 11th April, 1896, and serve as examples of questions proposed under the different sections.

Subject:—Engineering as applied to Municipal Work.

Examiner: W. Santo Crimp, M. Inst. C.E.

Land Surveying and Levelling.

1. Describe the manner in which, with the aid of a theodolite, the boundaries of an irregular block of buildings may be surveyed. Sketch an example.
2. Give a specimen page of a levelling book, and describe the methods of checking to be observed in cases where extreme accuracy is desirable.

Hydraulics.

3. Define the meaning of "wet perimeter" and "hydraulic mean depth," and describe the manner of obtaining the value of the latter in a channel running partly full.

Drainage and Sewage Disposal.

4. Describe the best way of constructing a water-tight sewer 12 inches in diameter, in wet ground, its depth to be 10 feet.
5. Describe the best manner of ventilating a system of pipe sewers.
6. In the case of sewers carrying off both sewage and street drainage, a greater velocity is necessary for the purpose of preventing deposits than in the case of sewers carrying off sewage only. Give the reason why this is so, and state the least velocities allowable in each case, at the time the sewers are running one-third full.

Sewage Disposal.

7. Explain why chemical processes are insufficient for the purification of sewage when a high degree of purity is necessary, also why the Local Government Board require land to be provided for sewage purification in the case of inland towns.
8. In many cases sewage farms on clay soils are quite successful, in others they are not. State why, and describe the means to be adopted in preparing such soils to ensure success.

Water Supply.

9. State the quantity required for various purposes, and describe means of preventing waste.

Road Making.

10. Describe the steps, in detail, to be taken in the case of making up a road, with a view to its being taken over by a Local Authority. Give a cross section, with details of the materials to be used, the road being 40 feet in width.
11. Give a brief description of the leading classes of street pavement, state the conditions under which each is found most effective.
12. Describe the different classes of footway pavements, and give the approximate cost per square yard.

Subject :—Building Construction, &c.

Examiner : James Lemon, M. Inst. C.E., F.R.I.B.A., F.S.I.

1. Make a section of the front wall of a warehouse four stories high, show concrete foundation, footings, damp-proof course, thickness of wall at each story, parapet, cornice, and gutter, and figure dimensions in all cases.
2. Write specification for bricklayers' work of an ordinary dwelling house, value, say 1000*l.*
3. Make sketches of raking shoring to a wall 40 feet high, flying or horizontal shoring between two buildings, 30 feet apart and 40 feet high, and needles to shore up a house to put in an iron girder 20 feet span, with wall over 25 feet high and 14 inches thick, and figure dimensions of timbers.
4. Draw plan of double floor to room 30 feet by 20 feet, and figure dimensions of girders and joists.
5. Make sketch of a timber roof truss 40 feet span, and figure dimensions of all timbers, including rafters and ceiling joists.
6. Show the same thing in iron, and figure dimensions of all materials employed.
7. Make figured section of a fireproof floor to a room in a public building 30 feet by 20 feet.
8. Draw figured cross section of a wrought-iron girder to carry 20 tons on the centre, with a 20 feet span.
9. Write specification for plumber's work to a lead flat, gutter, flushings, washdown closet, bath, and sink.
10. Describe the different limes and cements used by the plasterer for inside and outside work, and state in what way and in what proportions they should be used.

SUBJECT:—SANITARY SCIENCE.

Examiner: Joseph Lobley, M. Inst. C.E.

1. Describe the difference in the component parts of air and water, i.e. which is a chemical mixture and which is a mechanical mixture?

2. Describe the difference between carbonic acid and carbonic oxide, and state how these gases are produced, and their respective effects on human life.

3. Describe the principal chemical action that takes place in the animal system by (1) digestion of food, (2) circulation of the blood, (3) breathing; and in vegetable life state what is absorbed and what is given off.

4. What gases or vapours are given off by the combustion of (1) pure hydrogen, (2) coal gas, (3) charcoal or coke?

5. State the general principles as regards the ventilation of towns that are desirable.
   (*a*) Width of streets.
   (*b*) Length of streets without cross streets.
   (*c*) Minimum area of open space at rear of buildings and minimum distance between buildings at the rear.

6. Give simple tests for detecting the probable presence in water presumed fit to drink: (*a*) chlorine; (*b*) sewage pollution.

7. What minimum velocity is requisite for sewers to be self-cleansing, and how would you obtain that in flat districts?

8. Give briefly three principal modes of dealing with sewage at the outfall works, and the special circumstances justifying the adoption of any of them.

9. Sketch ground floor of a park lodge, with office, parlour, kitchen, scullery, pantry, and an exterior w.c., and first floor with three bed-rooms, bath-room, and w.c.; and show the best way of draining same and back yard into a sewer which is 20 yards from house, and 8 feet deep.

10. Give rules and regulation guiding the construction of (*a*) water-closet on first floor of above house; (*b*) the disconnecting chamber on drain, with sketch showing the inlet and outlet ventilators, &c.

11. Describe the slop water flushing closet, and state the advantages and disadvantages.

12. Describe the smoke test, and also the fume test, and how the same are to be applied to house drains.

SUBJECT:—MUNICIPAL AND LOCAL GOVERNMENT LAW AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

Examiner:—John T. Eayrs, M. Inst. C.E., F.S.I.

1. What are the chief differences between the powers of urban and rural authorities as to (*a*) roads, (*b*) streets, (*c*) buildings, (*d*) sewers, (*e*) gas and water supply?

2. Can a local authority make a sewer (not in a private street) for the purpose of draining private properties at the expense of the owners, and if so, under what circumstances?

3. State concisely the provisions of the model bye-laws, as to (*a*) new streets, (*b*) walls, (*c*) open space for new buildings, and (*d*) cleansing footways and pavements.

4. A local authority wishes to acquire land for the purpose of sewage disposal works, which the owner is unwilling to sell. Describe in detail the steps to be taken by the local authority to purchase it compulsorily.

5. Is a local authority compelled to offer facilities for the discharge of liquids from manufactories into their sewers, and under what conditions can they refuse to allow such discharge?

6. For what purposes is a water company compelled to supply water to a local authority under the Water Works Clauses Act; what are the general provisions relating to such supply; in case of difference as to charge for water, how is it to be determined?

7. What are the provisions of the Highway Act, 1835, with respect to (*a*) direction posts, (*b*) removal of snow and fallen banks, (*c*) repair of highways where the boundary of two parishes runs along the middle of the highway?

8. Define "main road" under the Highways and Locomotives Amendment Act, 1878. Under what circumstances may an ordinary highway become a "main road"?

9. State briefly the provisions of the Local Government Act, 1888, with respect to the maintenance of main roads and the expenses connected therewith.

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May 7, 1887	..	Adcock, C. (Liverpool).
May 2, 1891	..	Allen, S. (Radcliffe).
Apr. 22, 1893	..	Anderson, H. E. (Norwood).
Apr. 23, 1892	..	Anderson, J. R. (Norwood).
May 1, 1886	..	Angell, J. A. (Leytonstone).
May 19, 1894	..	Angel, R. J. (Birkenhead).
Oct. 20, 1894	..	Armstrong, J. G. D. (Manchester).
May 1, 1886	..	Ashmead, H. (Clifton).
Oct. 19, 1889	..	Aspinall, M. (Cardiff).
Apr. 20, 1895	..	Atkinson, W. (Bradford).
May 2, 1891	..	Ball, B. (Middleton).
Oct. 18, 1890	..	Ball, C. F. (Croydon).
Oct. 16, 1886	..	Ball, G. (Scarborough).
Apr. 23, 1892	..	Ball, J. B. (King's Cross).
May 12, 1888	..	Barnes, S. W. J. (Ealing).
Oct. 15, 1892	..	Bassett, G. T. (Birmingham).
May 12, 1888	..	Bayley, G. H. (Salford).
Oct. 16, 1886	..	Beard, E. T. (Lincoln).
May 12, 1888	..	Beynon, J. C. S. (Exeter).
Apr. 22, 1893	..	Birch, J. E. W. S. (Norwood).
Apr. 13, 1889	..	Blizard, J. H. (Southampton).
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Apr. 13, 1889	..	Bradley, J. W. (Burnley).
Oct. 21, 1893	..	Bradshaw, F. E. G. (Brighton).
Oct. 20, 1894	..	Bradshaw, H. G. (Rochdale).
Apr. 23, 1892	..	Bradshaw, J. B. (Gateshead).
Oct. 21, 1893	..	Brander, J. J. (Aberdeen).
Nov. 17, 1888	..	Brown, R. R. (Bridlington Quay).
May 19, 1894	..	Brown, R. (Ealing).
Oct. 16, 1886	..	Brownridge, C. (Leeds).
Apr. 25, 1896	..	Bruce, W. (Edinburgh).
Apr. 22, 1893	..	Brumell, W. F. G. (Redhill).
May 12, 1888	..	Bryans, J. G. (Sunderland).
Nov. 17, 1888	..	Bryning, W. G. (Liverpool).
Oct. 19, 1889	..	Bucknall, H. (Stratford-on-Avon).
Oct. 20, 1894	..	Burton, A. (Manchester).

Date of Certificate.		
Apr. 13, 1889	..	Carter, G. F. (Leeds).
May 3, 1890	..	Catchpole, J. H. (Hendon).
Apr. 22, 1893	..	Chasemore, A. E. (Putney).
May 19, 1894	..	Clarke, A. H. F. (Kingston-on-Thames).
May 19, 1894	..	Claypoole, A. H. (York).
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May 19, 1894	..	Coales, H. F. (Chelsea).
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Apr. 22, 1893	..	Colson, C. H. (Portsmouth).
May 19, 1894	..	Connah, E. (Glasgow).
Oct. 22, 1887	..	Cook, J. (Bury).
May 12, 1888	..	Cooper, C. H. (Wimbledon).
May 7, 1887	..	Cooper, F. E. (Liverpool).
May 2, 1891	..	Cooper, W. (Cheetham).
Oct. 19, 1895	..	Corrie, H. W. (Birkenhead).
Apr. 20, 1895	..	Creswell, W. T. (Aldershot).
Apr. 23, 1892	..	Cross, F. W. (Walsall).
May 12, 1888	..	Crow, A. (Stratford, E.).
Oct. 16, 1886	..	Crowther, J. A. (Leeds).
Apr. 25, 1896	..	Dalton, J. P. (Ryton-on-Tyne).
Oct. 21, 1893	..	Dawson, J. H. (Liverpool).
May 19, 1894	..	Daye, J. (Cardiff).
May 7, 1887	..	Dearden, Hy. (Leeds).
May 2, 1891	..	Dixon, J. R. (Carlisle).
Apr. 13, 1889	..	Dixon, W. B. (Wolverhampton).
Oct. 17, 1891	..	Dolamore, F. P. (Bournemouth).
Oct. 18, 1890	..	Dyack, W. (Aberdeen).
Oct. 18, 1890	..	Edge, F. J. (Barrow-in-Furness).
Apr. 20, 1895	..	Elford, E. J. (Norwich).
Apr. 25, 1896	..	Fell, P. O. (Norwich).
May 1, 1886	..	Fenton, W. C. (Sheffield).
Nov. 17, 1888	..	Field, W. C. (Eastbourne).
May 12, 1888	..	Finch, A. R. (Finchley).
Apr. 22, 1893	..	Finglah, F. J. (Walsall).
Apr. 23, 1893	..	Fitton, G. (Reading).
Apr. 20, 1895	..	Forbes, A. H. (Tottenham).
Oct. 19, 1895	..	Fox, S. F. L. (Batley).
May 7, 1887	..	Franks, T. W. (West Bromwich).
Oct. 19, 1889	..	Gaffney, F. S. B. (Athleague).
May 3, 1890	..	Gibbs, L. (Walsall).
May 12, 1888	..	Glass, S. N. (Hackney).
May 12, 1888	..	Gloyne, R. M. (Manchester).

Date of Certificate.		
Oct. 21, 1893	..	Gordon, Junr., J. (Aberdeen).
May 2, 1891	..	Graves, M. D. (York).
May 1, 1886	..	Greatorex, A. D. (Toxteth Park).
Oct. 20, 1894	..	Green, W. S. (Derby).
Oct. 15, 1892	..	Greenwood, J. P. (Barry).
Apr. 25, 1896	..	Griffiths, H. (Victoria Embankment).
Oct. 18, 1890	..	Hall, W. (Ealing, W.).
Nov. 17, 1888	..	Hawkins, I. T. (Chichester).
Apr. 25, 1896	..	Haywood, S. S. (Accrington).
Oct. 15, 1892	..	Hellawell, O. (Withington).
Apr. 20, 1895	..	Hendry, J. S. (West Bromwich).
Oct. 20, 1894	..	Hickes, E. W. (Truro).
Apr. 25, 1896	..	Hills, O. C. (Bow).
Apr. 23, 1892	..	Hills, H. J. (Clapham).
Apr. 20, 1895	..	Hodgkinson, G. (Manchester).
Apr. 25, 1896	..	Hogbin, L. W. (Minster).
Oct. 19, 1895	..	Horne, B. (Stourbridge).
May 12, 1888	..	Houghton, J. (King's Heath).
Oct. 20, 1894	..	Hughes, A. H. (Wrexham).
May 2, 1891	..	Hurd, H. (Bath).
Oct. 17, 1891	..	Ingham, W. (St. Helen's).
Oct. 16, 1886	..	Jameson, M. W. (Leeds).
Oct. 19, 1895	..	Jenkin, C. J. (Llandudno).
Apr. 20, 1895	..	Jenkins, A. J. (Rochdale).
Apr. 20, 1895	..	Julian, J. (Cambridge).
Apr. 25, 1896	..	Kieser, W. H. G. (Torquay).
Apr. 22, 1893	..	Killick, W. H. (Southampton).
Apr. 25, 1896	..	Kirk, J. W. (Westminster).
Oct. 15, 1892	..	Lacey, G. W. (Kettering).
Oct. 19, 1895	..	Liversedge, J. W. (Fulham).
Apr. 23, 1892	..	Lloyd, C. (Chatham).
Apr. 20, 1895	..	Lobley, F. J. (Hanley).
May 12, 1888	..	Lynam, G. T. (Barnsley).
Oct. 16, 1886	..	Mallinson, T. (Selby).
Oct. 18, 1890	..	Manley, J. (Liskeard).
Oct. 21, 1893	..	Martin, E. B. (Leeds).
Apr. 25, 1896	..	Maxwell, W. H. (Leyton).
Oct. 22, 1887	..	Mellor, T. E. W. (Stockton).
Oct. 22, 1887	..	Metcalf, J. W. (York).
May 3, 1890	..	Miller, J. E. (Durham).
Nov. 17, 1888	..	Millington, J. S. (Wavertree)
May 12, 1888	..	Milnes, G. P. (Wakefield)

Date of Certificate.		
Oct. 17, 1891	..	Naylor, W. (Wolverhampton).
Apr. 13, 1889	..	Nettleton, H. (Leeds).
Apr. 20, 1895	..	Newham, J. T. (Birmingham).
Oct. 20, 1894	..	Newton, E. B. (Carlisle).
May 7, 1887	..	Nichols, A. E. (Leeds).
May 7, 1887	..	Nickols, F. J. (Leeds).
Apr. 25, 1896	..	Nightingale, C. F. (Walsall).
Oct. 19, 1889	..	Noakes, H. S. (Tunbridge Wells).
Oct. 20, 1894	..	Openshaw, J. (Sheffield).
May 1, 1886	..	Osborne, F. (Dover).
Oct. 20, 1894	..	Palliser, W. A. (Mexboro).
Oct. 22, 1887	..	Parker, W. (Hereford).
Oct. 15, 1892	..	Parr, N. (Walsall).
Oct. 20, 1894	..	Perkins, J. (Balsall Heath).
Oct. 15, 1892	..	Perkins, T. L. (Bristol).
Oct. 16, 1886	..	Pickering, J. S. (West Bromwich).
Oct. 21, 1893	..	Pickering, S. A. (Burnley).
Oct. 21, 1893	..	Pickles, T. H. (Burnley).
Apr. 20, 1895	..	Poulden, G. E. (Southsea).
Oct. 19, 1889	..	Preston, T. (Bradford).
May 19, 1894	..	Price, A J. (Brighton).
May 12, 1888	..	Pritchard, T. (Richmond).
Apr. 22, 1893	..	Putman, W. E. (Leeds)
May 7, 1887	..	Rich, E. W. (Hounslow).
Oct. 17, 1891	..	Roberts, F. (Birkenhead).
May 2, 1891	..	Saise, A. J. (Stapleton).
May 1, 1886	..	Saunders, E. E. (Walthamstow).
May 7, 1887	..	Saunders, J. (Newark).
Oct. 21, 1893	..	Savage, E. B. (Sheffield).
Oct. 22, 1887	..	Saville, R. W. S. (Accrington).
May 19, 1894	..	Settle, J. A. (Darwen).
Apr. 23, 1892	..	Shackleton, C. W. (Coseley).
Oct. 16, 1886	..	Silcock, E. J. (Leeds).
Oct. 20, 1894	..	Slater, W. (Nottingham).
May 19, 1894	..	Smith, W. (Swanage).
Oct. 21, 1893	..	Steele, W. J. (West Hartlepool).
Apr. 13, 1889	..	Stringfellow, W. (Southampton).
Oct. 18, 1890	..	Sumner, F. (Kilburn).
Oct. 16, 1886	..	Sykes, E. (Reddish).
Apr. 13, 1889	..	Taylor, W. J. (Southampton).
Oct. 20, 1894	..	Thackeray, F. (Darwen).
Oct. 16, 1886	..	Thomas, R. J. (Carnarvon).

Date of Certificate.		
Oct. 19, 1889	..	Thomas, T. (Neath).
Apr. 13, 1889	..	Tomes, G. B. (Eastbourne).
May 19, 1894	..	Trew, G. H. M. (Lavender Hill, S.W.).
Oct. 16, 1886	..	Turner, V. H. (Leeds).
Apr. 20 1895	..	Uren, F. C. (Penzance).
Apr. 23, 1892	..	Veit, L. J. (Ipswich).
May 7, 1887	..	Verschoyle, B. (Liverpool).
Apr. 22, 1893	..	Videan, Hy. (Stafford, E.).
Oct. 22, 1887	..	Ward, F. D. (Manchester).
Apr. 20, 1895	..	Williams, D. S. (Mountain Ash).
May 12, 1888	..	Wilson, C. L. N. (Bacup).
Nov. 17, 1888	..	Wilson, J. B. (Cockermouth).
May 1, 1886	..	Witts, J. W. (Skelton).
May 3, 1890	..	Wood, J. W. (Rochdale).
Oct. 20, 1894	..	Worrall, F. (Leicester).
Oct. 15, 1892	..	Wright, J. A. (Bristol).
May 2, 1891	..	Yarwood, Hy. (Rochdale).
Apr. 23, 1892	..	Yates, F. S. (York).
Oct. 16, 1886	..	Young, W. (Pendleton).

Memoirs of Deceased Members.

The Council having been requested to append some short notice of the decease of Members of this Association, will feel obliged by early notice being forwarded to the Secretary, with such particulars as it may be desirable to insert in these 'Proceedings.'

William Crabtree, born on January 10th, 1826, died at his residence, 126 Manchester Road, Southport, on February 21st, 1896.

Mr. Crabtree, the late Borough Engineer of Southport, was the son of Mr. Richard Crabtree, Contractor and Quarry Owner, of Hebdon Bridge, Yorkshire, and for several years after leaving school assisted his father in his business.

He was appointed Borough Engineer of Southport in 1867, when the borough was incorporated, and has been engaged in municipal work ever since. With the exception of the laying of the main sewer, which was done from the plans of Mr. Mansergh, C.E., he had charge of the whole of the drainage of the town, the Promenade extension, the Marine Park and lakes, and many other works which have been carried out by the Corporation. He was a faithful and most conscientious servant of the Corporation, and his gentlemanly presence won him friends wherever he went, while in private life he was highly esteemed.

In 1895, on account of his ill-health, he was granted a three months' leave of absence, and as he seemed to be improving then the leave was extended.

Mr. Crabtree was, however, unable ever again to resume his official duties. He suffered from bronchial asthma and afterwards from general debility.

Mr. Crabtree was a Member of the Institution of Civil Engineers, and was elected a Member of this Association in 1887.

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PROCEEDINGS

OF

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

CONTENTS OF VOLUME XXI.

PAPERS AND DISCUSSIONS:

COLNE VALLEY WATERWORKS: BUSHEY PUMPING STATION.—E. B. Taylor.

HAMPSTEAD ELECTRIC LIGHTING INSTALLATION.—W. H. Preece.

DISCUSSION ON ARRANGEMENTS FOR STERILISING CHOLERA DEJECTA, Etc., ADOPTED AT NEWCASTLE-ON-TYNE.—W. G. Laws.

THE RIVER TEES FLOATING HOSPITAL, BELONGING TO THE RIVER TEES PORT SANITARY AUTHORITY.—T. W. Stainthorpe.

PRIVATE DRAINS OR PUBLIC SEWERS.—W. N. Blair.

NOTES ON COMBINED DRAINAGE.—R. Godfrey.

STOCKPORT SEWERAGE SCHEME AND MERSEY MILL BRIDGE.—A. M. Fowler.

MUNICIPAL PROGRESS AT STOCKPORT.—J. Atkinson.

BRIGHTON AND ITS MUNICIPAL WORKS.—F. J. C. May.

POINTS OF INTEREST IN THE DEVELOPMENT OF ELECTRICITY SUPPLY AT BRIGHTON.—A. Wright.

THE SUPPLY AND DISTRIBUTION OF WATER AT BRIGHTON.—J. Johnston.

SOME OF THE RECENT PUBLIC WORKS OF CARDIFF.—W. Harpur.

PLYMOUTH AND ITS MUNICIPAL WORKS.—J. Paton.

THE WATER SUPPLY OF PLYMOUTH.—E. Sandeman.

PRESIDENT'S ADDRESS.—Edward R. S. Escott.

ROYTON SEWAGE WORKS.—T. S. McCallum and W. Naylor.

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